1.4 Environmental restoration personnel shall demonstrate a familiarity level knowledge of reading and plotting graphs and interpreting graphical data.

Supporting Knowledge and/or Skills

The following information provides the necessary basic information to have a familiarity level of knowledge for “Reading and Plotting Graphs and Interpreting Graphical Data.”

a. Solve for the unknown given a linear equation with multiple units such as the Environmental Protection Agency risk equation.

As an example, the equation for risk-based concentration (C) for inhalation of fugitive dust for nonradioactive carcinogenic compounds is:

C = (target risk * body weight * averaging time * particulate emission factor) ÷ (inhalation slope factor * inhalation rate * exposure frequency * exposure duration)

$$C = \frac{TR*BW*AT*PEF}{ISF*IR*EF*ED}$$

Consequently, the units for the resulting equation may be defined as Concentration [=] (Kg * yr * 365 days/yr * m^3/kg) ÷ [(kg-day)/mg * m^3/day * day/yr * yr] [=] mg/kg. Once the correct units have been accounted for in the equation (conversion factors, cancellations, etc.), the data is inputted into the equation (such as the body weight, average time, etc. in the above example) and the resulting value (C) calculated.

b. Given a graph, interpret meaning of slope and intercept, such as slope factor for a carcinogenic chemical.

The typical form for a linear equation is given by Y = AX + B. This equation, and raw data that fit this type of equation, can be plotted on normal graph paper with the horizontal axis representing X and the vertical axis representing Y (Figure 1.4-1). This type of graph will show a straight line with a slope (rise over run = change in Y over the change in X) that would have a value of A. This line would also have a Y intercept with a value of B. For a **carcinogenic chemical**, the Y axis could represent the risk based concentration for inhalation, and the X axis either the duration of exposure or the amount of material (dust) to which a person is exposed. The slope would then represent the change in concentration with changes in time. The Y intercept would represent the resulting concentration for no duration exposure (t=0).

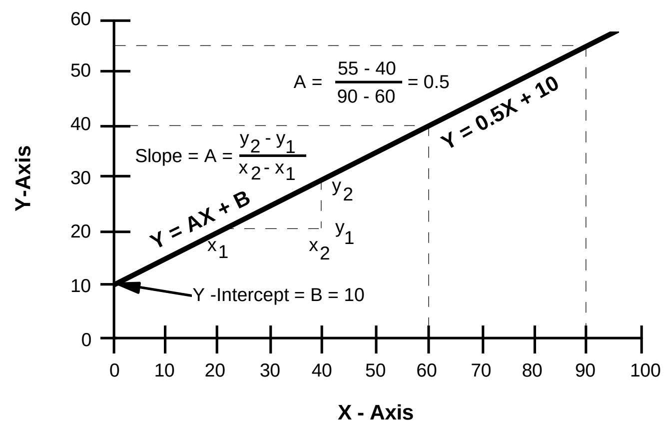

Figure 1.4-1 General Graph Configuration and Explanation of Slope, Y-Intercept, and the Equation of the Line

c. ***Interpret data on a simple graph, such as time/concentration.***

This type of graph would provide for "**Time**" along the X axis and "**Concentration**" along the Y axis. If the resulting graph shows a straight line, the slope could be calculated from graphical data and the Y intercept read directly off the graph. Per the discussion presented in Section 1.4(b) and given a straight line plot, the slope would represent the change in concentration with time, and the Y intercept would represent the concentration at time zero. A straight line would indicate that this concentration change with time was constant. Therefore, if the concentration was known at any given time (such as time = 0), the concentration at any other time could be calculated using the equation in Section 1.4(b).

d. ***Given a table of data, plot the data points on a Cartesian Coordinate Graph.***

There are several ways in which data can be plotted. The data can be plotted on normal graph paper where each demarcation represents a fixed amount for a given variable (kg, seconds, days, apples, etc.). This type of rectangular plot is called a **Cartesian Coordinate System Graph**. It consists of two perpendicular coordinate lines that intersect at the origin (value = zero). The horizontal axis is the x-axis and the vertical axis is the y-axis. Each coordinate line has regular and fixed increments for the variable represented by that axis. The plane defined by the two axes is called the coordinate plane or the xy-plane[1]

e. ***Given a table of data, plot the data points on a logarithmic coordinate graph.***

Data can also be plotted on other types of graph paper with a **logarithmic coordinate** such as log normal or log-log graph paper. These types of plots may sometimes show a useful trend (such as straight lines) from which certain conclusions may be inferred. The term "log", log-log, or log-normal graph denotes a graph that has the divisions along an axis based on the log base 10 (log_{10}) system or natural log (ln) system. The term "normal" denotes standard uniform fixed deviations (Cartesian Coordinate) along that particular axis (such as in a log normal graph). These types of special graph paper make developing these graphs simple as the "raw data" can be plotted directly onto the graph without any conversion. If specialized graph paper is not available, the data can be converted (log of the raw value calculated) and the resulting transformed data plotted on normal graph paper. The resulting graph (for both cases) would appear identical in shape.

f. Given a graph, determine the slope of a line.

Per the discussion provided in Sections 1.4(b) and (c), the **slope** can be calculated (off the graph) by selecting any two points along the straight line (preferably as far apart as possible) and determining their x and y values or coordinates (x_1, y_1) and (x_2, y_2). From this data, the slope can be calculated using: Slope = change in Y ÷ change in X = (y_2-y_1)/(x_2-x_1). The resulting numerical value would then be used as the value for the variable "A" listed in Section 1.4(b). The Y intercept (x=0) would provide the value for "B" in the 1.4(b) equation.

[1] Swokowski, Earl, W., *Calculus with Analytic Geometry*, 2nd. ed., Prindle, Weber & Schmidt, Boston, MA, 1979.

1.12 Environmental restoration personnel shall demonstrate a familiarity level knowledge of the relationship of each of the following disciplines to environmental restoration.

- Ecology
- Meteorology
- Hydrology
- Geology
- Geochemistry
- Seismology
- Toxicology

Supporting Knowledge and/or Skills

a. Describe how each of the listed scientific disciplines contributes to environmental restoration activities.

Ecology is the science of the interactions and relationship between living organisms and their environment. Protection of ecological resources is important in the selection of remedial alternatives for environmental restoration projects.

Meteorology is the science concerned with atmospheric phenomena, especially weather, weather conditions, and climate. Inclement weather conditions, such as tornadoes, rain, and wind, may affect implementability of remedial alternatives or may bias sampling results.

Hydrology is the study of all water in and upon the earth including the hydrologic cycle. Knowledge of the local and regional hydrology (relationship between groundwater and surface water) is important in the selection of remedial alternatives for source and groundwater operable units, as well as meeting clean up standards. Hydrogeology is the study of those geologic factors that relate to and influence subsurface water movement. Understanding of a site's hydrogeology is important in defining fate and transport of contaminants, genesis of contaminants, and the groundwater flow system in which contaminants act.

Geology is the science dealing with the origin, history, and structure of the earth. Consideration of primary geologic parameters (structure and stratigraphy) are important in the prediction of contaminant fate and transport in the subsurface, as well as selection of remedial alternatives.

Geochemistry is the study of chemistry and the distribution of elements and compounds in soils, rocks, and earth fluids (groundwater, surface water, etc.). Knowledge of geochemistry is essential in predicting mobility of contaminants in the vadose zone and in saturated sediments, as well as the form (valence) of metallic contaminants.

Seismology is the study of earthquakes and the mechanical properties of the earth. Future seismic events must be considered in the design of facilities that support environmental restoration, such as construction of a storage or disposal facility.

Toxicology is the study of the nature, effects, and detection of poisons and the treatment of poisoning. Toxicological data is often used as the basis for risk assessments in environmental restoration projects.

b. Describe the interrelationship between the listed scientific disciplines and environmental restoration activities.

Defensible investigations and studies require input from a multiple of scientific disciplines, including those disciplines listed above in Section 1.12(a). Several environmental acts [including the Resource Conservation and Recovery Act (RCRA) 42 U.S.C.A § 6901, the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) 42 U.S.C.A § 9601, and the National Environmental Policy Act (NEPA) 42 U.S.C.A § 4321] require assessments of existing conditions and potential impacts to human health and the environment for the evaluation of proposed actions.

RCRA and CERCLA require studies and investigations for environmental media or facilities that have had a release or where a threat of a release posing a risk to human health or the environment exists. First, a remedial investigation is conducted to characterize the nature and extent of contamination. The investigation develops detailed information, including hydrological and climatological conditions, soil characteristics, surface and sediment quality, and air quality. These data are analyzed and presented in a RCRA Facility Investigation (RFI) or Remedial Investigation (RI) report. Human and environmental systems that may be exposed to releases are assessed. The human health and ecological evaluations are presented within the RFI or RI as the Baseline Risk Assessment (BRA). The BRA presents an analysis of the human health and ecological risk present at the site. Samples of soil, surface water, and groundwater are taken and analyzed.

Upon completion of the remedial investigation, a corrective measures feasibility study is conducted. This study is a mechanism for the development, screening, and detailed evaluation of remedial action alternatives. The detailed analysis consists of an assessment of individual alternatives against evaluation criteria [40 CFR 300.430(e)(9)(iii) for CERCLA and 40 CFR 264.525(a) for RCRA]. The criteria for both Acts include overall protection of human health and the environment; short-term effectiveness (including the short-term risks to community and workers); and reduction of toxicity, mobility, or volume of the contaminants.

NEPA requires the development of an environmental impact statement or an environmental assessment for each proposed major Federal action. Included in this process is the evaluation of existing conditions and potential impacts to the environment. The Council on Environmental Quality (CEQ) regulations (40 CFR 1500-1508) require an interdisciplinary approach for defensible scientific analysis, concentrating on significant issues, and an objective evaluation of reasonable alternatives to the proposed action. The planning process should result in informed decisions that reflect environmental values.

1.13 Environmental restoration personnel shall demonstrate a working level knowledge of environmental monitoring and field data collection techniques.

Supporting Knowledge and/or Skills

a. Describe the various types of environmental monitoring and the purpose of each performed at a site.

Environmental monitoring consists of collecting samples for analyses from different media such as air, surface water, groundwater, and soil. Analytical data can be used to track whether or not releases have occurred in the past or are continuing from a site and to determine the potential fate, direction, and transport of contaminant migration. Monitoring data can also be used to maximize remedial design and the proper placement of remedial systems.

Air

Air monitoring consists of methods to measure air emissions from individual buildings (effluent) and in the surrounding environment (ambient). Examples of emissions include particulate matter (e.g., dust and fly ash), gases (e.g., carbon dioxide, carbon monoxide, sulfur dioxide, and nitrogen oxides), organic vapors (e.g., carbon tetrachloride, gasoline), and radioactive nuclides (e.g., plutonium, radon). The data generated are used to support compliance with applicable state and federal air quality regulations, and to help provide assurances that protection of the health of plant workers and the general public is being maintained.

Surface Water

Surface water monitoring consists of methods for measuring river stage and flow, lake and reservoir level, and estuary stage and circulation. These methods include direct and indirect techniques for measuring hydrologic variables such as flow velocity, depth, and volume. Surface water samples can be collected for chemical analysis and water quality parameters. Surface water is extensively analyzed to ensure that water quality standards are met, to characterize background water quality, and to detect and evaluate potential contaminant releases from specific locations.

Groundwater

Groundwater monitoring consists of methods for measuring hydrogeologic and hydrologic properties of groundwater flow systems. These measurements are used for groundwater protection, regulatory compliance, and resource appraisal and management. Groundwater samples can be collected for chemical analysis and water quality parameters. Groundwater monitoring programs are designed to determine background values, to measure the concentration of hazardous constituents, to measure hydrologic parameters of the aquifers, and to estimate the rate and direction of movement and extent of contaminant plumes, and to help in remedial design decisions.

Soil

Soil monitoring consists of visually classifying soils in the field or collecting samples for detailed laboratory classification and chemical analysis. In general, soil monitoring is performed to determine the nature and extent of soil contamination, to measure the permeability of the soil medium, to determine soil mineralogy for contaminant fate and transport analyses, and to characterize engineering properties. Analytical data can be used to evaluate the changes in radiological concentrations that might occur through soil resuspension or other mechanisms, and to compare radiological concentrations in soils from year to year.

b. ***Describe the equipment used to monitor and the parameters being measured for the following:***

- Air
- Surface water
- Groundwater
- Soil
- Ambient air quality
- Emissions
- Groundwater contamination
- Meteorological factors
- Streams and rivers contamination
- Soil and sediment contamination
- Wildlife contamination

Air

Sampling of ambient air quality requires different analytical techniques and equipment depending on the physical phase (gaseous, aerosol, or condensed water) of the atmosphere and the contained chemical species under consideration. In the absence of the condensed aqueous phase, aerosol particles are removed by filtration (impaction, diffusion, or interception onto a filter surface) with the air stream analyzed for the contaminant of concern.[1]

Particles may be collected by a variety of techniques including gravitation settling, filtration, electrostatic and thermostatic precipitation, and impaction. Of these, gravitational settling, filtration, and impaction have been the most widely used for sampling ambient particulate matter.

The simplest particle sampling method employs the principle of gravitational settling. Large settleable particles are collected in an open top vessel placed in the atmosphere for a period of 30 days. This is a static or passive sampling method requiring no air-moving equipment. This method has been used for a long time.

Hi- volume Sampling The hi-volume sampler has been the most common particle sampling device employed in ambient air quality monitoring programs. A collecting glass fiber filter is located upstream of a heavy-duty vacuum cleaner type motor which is operated at a high air flow rate (40-60 cubic feet/minute). The sampler is mounted in a shelter with the filter parallel to the ground. The covered housing protects the glass fiber filter from wind and debris, and from the direct impact of precipitation. The hi- volume sampler collects particles efficiently in the size range of 0.3-100 micrometers. The mass concentration of total suspended particulates is expressed as micrograms per cubic meter for a 24-hour period. The hi- volume sampler is an intermittent sampling method. It is normally operated on a 6-day sampling schedule, with a 24-hour sample collected every sixth day.

Paper Tape Samplers Different than hi-volume samplers, paper tape samplers are continuous sampling devices. They do not show instantaneous data and usually indicate concentration average times of two hours. The sampler draws ambient air through a cellulose tape filter. After a 2-hour sampling period, the instrument automatically advances to a clean piece of tape and begins a new sampling cycle. Because of difficulties in relating data acquired by this optical method to the gravimeteric data of the hi-volume reference method, most paper tape sampling has been discontinued or used only as a backup system.

Size Selective Samplers Various sampling devices are available that segregate collected suspended particulate matter into discrete size ranges based on their aerodynamic diameters. These samplers may employ one or more fractioning stages. The physical principle that is used in the segregation is inertial impaction of the particle. Therefore, these samplers are referred to as impactors.

Impactors draw air through the unit and deflect the particle from its original flow path. The size of the particle depends on: (1) gas velocity, (2) particle density and shape, (3) air flow geometry, (4) gas viscosity, and (5) the main free path of the gas.[2] Multistage impactors can fractionate suspended particles into six or more size fractions depending on the number of stages built into the sampler. Impactors can fractionate suspended particles into coarse (from 2.5-10 micrometers) and fine (less than 2.5 micrometers) size fractions. The smaller fraction impactors are referred to as dichotomous impactors. EPA reference method specifications for PM_{10} can be met by a variety of devices, including both cascade and dichotomous samplers.

A multiple slotted-rod collector inserted through the skin of an aircraft can be used to collect samples of liquid water from clouds, with water collection taking place within the aircraft for analysis. Supercooled cloud water can be collected on any surface outside of the aircraft's slipstream, but phase transitions can render the results ambiguous.[1]

Continuous gas-phase techniques are commonly used for airborne monitoring of ozone, carbon monoxide, nitrogen oxides, sulfur dioxide, ammonia, peroxyacyl nitrate, and hydrogen peroxide. Ozone is monitored using the ethylene chemiluminescence technique with precision of $\pm$10% or better, and accuracy in the range of 20 to 200 ppb. Carbon monoxide is monitored using nondispersive infrared (IR) spectroscopy. Nitrogen oxides (NO_X) are measured using the chemiluminescent reaction of ozone with NO_X and viewed with a red-sensitive photomultiplier tube. Sulfur dioxide detection requires a modified flame photometric detector. Ammonia monitoring uses Venturi collection, chemical reaction to an ammonia derivative such as isoindole, and determination by fluorescence in a flow-through fluorimeter. Gaseous peroxides are difficult to collect and analyze without generation of "artifact" peroxides. Artifacts are constituents that are detected and may mask the actual contaminant present. Use of diode-laser absorbence, ozone removal techniques, and prompt derivation and analysis have yielded "artifact-free" results.[1]

Aerosol monitoring (in situ) of aerosol number, size distribution, and mass can be performed with a nephelometer (mass), an electrical aerosol analyzer, optical particle counters, optical particle probes, and impactor separation with piezoelectric balance.[1]

Organic components are separated by use of the appropriate filtering media and a high volume particulate sampler, with analysis performed for the component of concern using the appropriate analytical equipment (gas chromatography-mass spectroscopy, flame ionization, electron capture, infrared spectroscopy, etc.). Inorganic particulates can be analyzed using scanning electron microscopy or a variety of chemical techniques.

Liquid Bubblers Liquid bubblers are used to measure concentrations of oxidized sulfur compounds (SO_x) and ozone (O_3) in the atmosphere. These devices collect gases by bubbling ambient air through a liquid medium that dissolves the components of interest. Although bubblers are constructed to provide long-term reliability, they are not recommended for use in long-term monitoring in the United States because the liquid medium may evaporate or promote chemical speciation of the target compounds.[1]

Infrared Spectrometer A nondispersive infrared (IR) spectrometer is commonly used to measure carbon monoxide (CO) concentrations and can be modified to analyze nitric and sulfuric acid concentrations. The device measures the attenuation of specific wavelengths of infrared light which is compared to a reference cell containing a known quantity of CO. Airborne instruments have a detection limit of approximately 50 ppb with a time resolution of 10 seconds.[1] Nitric acid can be detected to a level of 4 parts per billion (ppb) by using Fourier transform infrared spectroscopy. An IR-tunable diode laser spectroscope can detect nitric acid at a level of 100 parts per trillion (ppt). Using technique termed IR-laser backscattering, sulfuric acid can be detected at concentrations of less than 1g/m^3.

<u>Surface Water</u>

See section on streams and rivers contamination.

Groundwater

See Section on groundwater contamination.

Soil

See section on soil and sediment contamination.

Ambient Air Quality

See section on air.

Emissions

Emissions are sampled and analyzed using the same types of equipment and techniques (to detect the same type of substances) as were previously listed under the air section. Sampling and analysis procedures for pollutants from stationary sources are listed under 40 CFR Part 60. For example, among these methods is EPA Method 3A (to detect carbon monoxide [CO] and oxygen [O]), EPA Method 6C (for the detection of sulfur oxides [SO_x] by pulsed fluorescence), and others for particular contaminants of concern.[1]

The term “effluent” refers to something that flows out into the environment. At DOE sites, effluent air refers to air emissions released to the environment from processing and laboratory facilities. Ventilation and filtration systems constantly filter the air while monitoring equipment measures emissions to the environment.

Radionuclides such as plutonium, uranium, and americium occur as solid particles. As a result, particle filtration of airborne effluent streams is an important and effective means of preventing the release of these materials to the environment. Radioactive particles enter exhaust air streams where the particulate materials are removed by High Efficiency Particulate Air (HEPA) filters.

HEPA filters are designed to be fire- and chemical-resistant. They are constructed of tiny glass fibers combined with a small amount of organic material added for strength and water repellency. Multiple banks of HEPA filters, called filter plenums, are installed in series in air exhaust systems.

At Rocky Flats, the radiological particulate monitoring program uses a three-tier approach, comprising Selective Alpha Air Monitors (SAAMs), total long-lived alpha screening of air duct emission sample filters, and radiochemical analysis of isotopes collected from air duct emission samples. This approach balances both detectability and timeliness of results. SAAMs are sensitive to specific alpha particle energies. Therefore, for immediate detection of abnormal conditions, monitor alarms can be automatically programmed to sound if any out-of-tolerance conditions are detected.

At regular intervals, particulate material samples from continuous sampling systems are removed from the exhaust systems and radiometrically analyzed for long-lived alpha emitters. Composite samples can be subjected to radiochemical separation and alpha spectral analysis, which quantifies specific alpha-emitting radionuclides. Bubble-type samplers are used to determine tritium concentrations and are measured using a liquid scintillation photospectrometer.

A variety of techniques are used to monitor radiation in air, soil, and water. Table 1.13-1 gives examples of the types of devices used and their application.

Table 1.13-1
Examples of Radiation Monitoring Devices

Detector Type	**Instrument**	**Radiation Detected**	**Application**
Ionization Chambers	Victoreen 440 (non-portable)	Gamma	Building entryways, health physics measurements
Gas Proportional	Ludlum 12-1A (hand-held, portable)	Alpha	Screening small areas, equipment, and personnel. Lab measurement of water, air, soil, and smear samples.
Geiger Mueller	Ludlum 31 (hand-held portable)	Beta, Gamma	Surface scanning, surface contamination measurement.
Scintillation	Bicron Fidler (hand-held portable)	Gamma, X-ray	Surface scanning, lab gamma ray spectroscopy, in situ surface contamination measurement.
	Ludlum 111 (portable on a wheeled cart)	Alpha	Surface contamination measurement, lab measurement of air, soil, water, and smear samples.
Semiconductor	HPGe (vehicle-mounted)	Gamma, X-ray	In situ characterization of soil or rock via gamma ray spectroscopy.
Electrometer	Long-range alpha detector (LRAD) (hand-held to tractor-mounted)	Alpha	In situ characterization of soil, rock, air, or other solid media. Unit measures ions produced by alpha radiation using an induced current.

Radiation monitoring can be done in situ (e.g., a scintillation detector is set atop soil to obtain a site-specific measurement), by collecting samples and transporting them to a lab for analysis, or by scanning broad regions to locate areas of higher than normal radiation (e.g., mounting a semiconductor detector on the back of a vehicle and driving around a site). Specific project requirements and the radioactive elements of interest (whether they are alpha or beta emitters) determine the optimum monitoring technique.

Groundwater Contamination

Monitoring groundwater contamination is accomplished through collection of groundwater samples from a series of wells. A series of wells is typically installed to define the extent of contamination and to determine whether a "plume" of contamination exists. A number of wells are required to ascertain the direction of flow and rate of movement. Baseline conditions, which provide a basis for comparison, can be determined by collecting samples from nearby wells that are known to be free of contaminants. Groundwater samples are subjected to chemical analysis for constituents of interest, with temporal changes in the chemistry of a given location providing information regarding contamination variability, and possibly trends and movement of the contaminant over time. Evaluating changes in groundwater chemistry requires knowledge of changes in related factors such as water table elevation and subsurface flow rate. Table 1.13-2 lists some of the devices used for sampling groundwater quality monitoring wells:

Table 1.13-2
Groundwater Sampling Devices[3]

Type	Advantages	Disadvantages
Bailer	Can be constructed in a wide variety of diameters	Sampling procedure is time consuming sometimes impractical to properly evacuate casing before taking samples
	Can be constructed from a wide variety of materials	Aeration may occur when transferring water to the sample bottle
	No external power source	
	Extremely portable	
	Low surface area to volume ratio, resulting in a very small amount of outgassing of volatile organics while sample is contained in bailer	
	Easy to clean	
	Readily available	
	Inexpensive	
Suction-lift Pump	Relatively portable	Sampling is limited to situations where water levels are within about 20 ft of the ground surface
	Readily available	Vacuum effect can cause the water to lose some dissolved gas
	Inexpensive	
Air-lift Samplers	Relatively portable	Causes changes in carbon dioxide concentrations; therefore, this method is

Table 1.13-2
Groundwater Sampling Devices[3]

Type	Advantages	Disadvantages
		unsuitable for sampling for pH-sensitive parameters
	Readily available	In general, this method is inappropriate for acquiring waste samples for detailed chemical analyses because it promotes sample degassing
	Inexpensive	
	Suitable for well development	
Gas-operated Pump	Can be constructed in diameters as small as 1 inch	Gas source required
	Can be constructed from a wide variety of materials	Large gas volumes and long cycles are necessary when pumping from deep wells
	Relatively portable	Pumping rates are lower than those of suction or jet pumps
Gas-operated Pump(Cont)	Reasonable range of pumping rates	Commercial units are relatively expensive
	Driving gas does not contact water sample, eliminating possible contamination or gas stripping	
Submersible Pump	Wide range of diameters	With one exception, submersible pumps are too large for 2-in diameter boreholes
	Constructed from various materials	Conventional units are unable to pump sediment-laden water without incurring damage to the pump
	12-volume pump is highly portable; other volume units may not be as portable	1 3/4-inch pump delivers low pumping rates at high heads
	Depending on size of pump and pumping depths, relatively large pumping rates are possible for wells larger that 2-in diameter	Smallest diameter pump is relatively expensive
	1 3/4-inch helical screw pump has rotor and stator construction that permits pumping fine-grained materials without damage to the pump	

In addition to the use of monitoring wells, other methods and equipment are often used in studies of groundwater contamination. These methods include other sampling techniques as well as geophysical methods. Surface geophysical surveys and downhole geophysical logging are used to define geological characteristics and assist in delineating zones of groundwater flow and contaminant transport. The discussion on borehole geophysical methods relies on Driscoll (1986).

- Pressure-vacuum **lysimeters** may be used to obtain samples of in situ soil moisture in the unsaturated zone. They consist of a porous ceramic cup capable of holding a vacuum, a small-diameter sample chamber made of PVC pipe, and two sampling tubes leading to the surface.

- A **piezometer** measures pressure and is frequently used for monitoring water pressure in earthen dams, under foundations, or in aquifers. It can also be used to measure vertical head differences under unconfined conditions. Piezometers are also used to monitor water levels.

- A **tensiometer** consists of a porous cup attached to an airtight, water-filled tube. The porous cup is inserted into the soil at the desired depth, where it comes into contact with the soil water and reaches hydraulic equilibrium. Water moves through the porous cup from the tube into the soil. A vacuum is created at the top of the airtight tube and is a measure of the pressure head in the soil. The measured pressure head is then converted to a calculated hydraulic head.

- **Organic vapor analyzers** are used to detect volatile organic carbon (VOC) compounds in groundwater. Field organic vapor analyzers are inserted into the air space above the groundwater table in a monitoring well to measure the air quality and indicate the presence of VOC compounds emitted from contaminated groundwater.

- A **Cone Penetrometer (CP)** has five main applications: 1) to determine the soil profile and identify the soils present, 2) to interpolate ground conditions between control boreholes, 3) to evaluate the engineering parameters of the soils and to assess bearing capacity and settlement, 4) to extract samples for the detection and quantification of hazardous materials in subsurface soils and groundwater, and 5) to detect and measure the migration of subsurface contaminants through the measurement of groundwater flow, imaging techniques, and/or other methods. The CP has a standard set of sensors for measuring cone tip pressure, sleeve friction, soil conductivity, and pore pressure. By measuring these parameters, contamination can be detected in both soils and groundwater.

- The **Geoprobe** collects one-time groundwater samples in unconsolidated material. It is driven into the soil and when the bottom of the probe is at least 5 ft below the water table, the outer cylinder can be pulled back exposing a perforated stainless steel sample entry barrel covered with either a nylon or polyethylene filter material. Hydrostatic pressure forces groundwater into the sample compartment. The geoprobe is an inexpensive method of obtaining a groundwater sample, but may be of limited application in certain types of geologic materials (e.g., highly consolidated materials, etc.).

- **Soil Gas Surveys** are used to assist remedial investigations where the contaminants of concern include volatile organic compounds (VOCs). Soil gas surveys are most effective in mapping low molecular weight, halogenated solvents and petroleum hydrocarbons. They are used to delineate VOC contamination in subsurface soils and groundwater. There are two basic soil gas equipment configurations. First, a mobile van-mounted probe that can collect samples in real-time and perform chemical analysis in the van. This method has been used to define contamination phases and direct placement of wells while in the field. The other configuration emplaces static samplers in the soil approximately one foot deep. These samples are usually collected on a grid. Soil gas surveying results are usually considered to be qualitative data and are not sufficient by themselves to characterize a site. This is because the results do not reflect the concentration of contaminants in the soil or groundwater.

- **Ground Penetrating Radar** (GPR) is used for the detection of buried waste, waste trenches and pits, and void spaces. GPR can often be employed in areas with extensive infrastructures and search depth can be set to be highly site specific. GPR is based on the physical property of measuring two-way travel time to reflection caused by changes in dielectric constants.

- A **Time Domain EM Object Detector** detects anomalies in transient Electromagnetic (EM) fields. EM is used for the detection of electrically conductive buried objects, pipes, waste pits and trenches, landfill boundaries, and cells within landfills. With EM, interference by infrastructure is substantially mitigated.

- **Magnetic (Mag) Surveys** measure the total magnetic field and vertical gradient of the magnetic field. Mag is used to detect ferromagnetic debris, drums, underground storage tanks (USTs), landfill boundaries, and uncontrolled waste pits and trenches. Mag has limited application within areas with extensive infrastructures and surface debris because of interference from these items.

- **Frequency Domain EM Profiling** measures ground conductivity and anomalies in the EM field caused by metallic objects. EM is used to detect and delineate waste pits, trenches, landfill boundaries, and contaminant plumes dissolved in ground water. EM has limited application within areas with extensive infrastructure and surface debris.

- **Metal Detectors/Pipe Detectors** measure distortions in electromagnetic (EM) fields. They are used to detect metallic objects and pipes. They are limited in the below surface depth they can detect.

- **Shallow Seismic Surveys** are used, in conjunction with subsurface borehole data, to generate a geologic model which can show preferred flow paths for groundwater and plumes. Additionally, subsurface features such as faults can be detected as part of the characterization of the flow regime. From these data further investigation or remedial alternatives can be planned.

- **Borehole Resistivity Logs** are usually referred to as electric logs when combined with spontaneous potential curve information. The electric log gives a detailed picture of the character and thickness of the various strata at the well site and an indication of the water quality by measuring the apparent resistivity of the materials surrounding the well bore. Electric logs offer several important advantages. These include locating the top and bottom of each distinct formation, determining relative water quality, and differentiating clean sand strata from silty sand strata and from sand strata with clay stringers. An electric log is obtained by lowering one or more electrodes which are suspended on a conductor cable into a borehole filled with drilling fluid. An electric current is forced to flow from these electrodes to other electrodes that may be in the borehole or placed in the ground near the top of the well. The electric logging instrument measures the current loss (resistance to flow) between two electrodes. Changes in electrical resistance of the entire circuit are recorded against depth to produce a graph or curve called an electric log or resistivity log. Many factors found in the subsurface can influence the resistivity of the formation including the physical properties of the drilling fluid, the rock formation chemistry, the presence of contamination, etc. All these factors must be taken into consideration when interpreting the resistivity log.

- **Spontaneous Potential Logs** Spontaneous potentials (SP) are naturally occurring electrical potentials (voltages) that result form chemical and physical changes at the contacts between different types of subsurface geologic materials. For example, a clay layer and an underlying sand layer will have a horizon of contact that marks their different potentials. These potentials become more pronounced when the pressure in the borehole greatly exceeds the pressure in the formation with depth. SP is measured by lowering an electrode into an uncased borehole filled with drilling fluid by means of a cable connected to one terminal of a millivolt meter and recorder. The other terminal of the instrument is connected to a ground terminal at the surface which is often placed in the mud pit. No external electricity is applied to the circuit. The downhole electrode is usually negative with respect to the surface electrode. As the electrode is moved up and down in the borehole, the meter registers variations in SP of the different formations. The SP log consists of a curve of these potentials plotted against depth. Different geologic materials demonstrate distinct curves as do formations containing saltwater or contaminants.

- **Gamma Logs** In gamma logging, measurements are made of naturally occurring radiation coming from the materials encountered in the borehole. The record of gamma radiation is used as a qualitative guide for stratigraphic correlation and permeability. In some areas, a direct relationship can be established between gamma radiation and permeability. Certain radioactive elements are naturally occurring in igneous and metamorphic rocks and as depositional particles in sedimentary rocks. As the gamma radiation is emitted from certain geologic materials, the materials become unstable and decay spontaneously into other more stable elements. Detection of gamma-ray emissions involves two random processes. First, the rays are given off at random intervals by the radioactive minerals. Second, these irregularly spaced pulses collide randomly with the detecting element in the logging probe. The collisions per unit time are then correlated with depth and a curve is generated called a gamma log.

- **Gamma-Gamma Logs** This type of logging uses an active source of gamma radiation (usually cesium-137 or cobalt-60) which is lowered into the borehole along with a detector that is shielded so it counts only the back-scattered gamma rays. The source and detector are placed up to 15 inches apart and are set against the borehole wall by mechanical arms. The gamma rays are directed into the formation surrounding the borehole. Because the amount of back-scattered radiation depends on the electron density of the formation, the recorded counts are approximately proportional to the bulk density. Density and porosity are inversely related. Thus, in general, the higher the density, the lower the porosity. The gamma-gamma log is sometimes referred to the density log. This log can be used to calculate the porosity of a formation when the fluid and grain densities are known.

- **Neutron Logs** are used primarily as an indicator of total porosity under saturated conditions. They are also used to measure the amount of moisture in unsaturated zones. The log is obtained by recording the number of neutrons impinging on a detector mounted some distance from a constant neutron source (americium-241 or beryllium) in the borehole. Before reaching the detector, many of the neutrons emitted from the source collide with various particles, lose energy, and eventually are captured. Most of the energy is lost in collisions with hydrogen ions. Because hydrogen is a principal component of water, the loss in energy indicates the amount of water present. If the energy loss is large, the amount of hydrogen in the formation must be high, and therefore the porosity is large.

- **Acoustic Logs** are useful in determining relative porosities of different formations and are widely used to verify how well the casing has been cemented to the formation. This log is called the cement bond log. The acoustic log is used to determine fracture patterns in the aquifer and thus is valuable in estimating where groundwater flow may be concentrated in semiconsolidated or consolidated rocks such as sandstone, conglomerates, and igneous rocks. The acoustic log measures travel time and the attenuation of an acoustic signal created by an electromechanical source in the borehole. A transmitter in the borehole converts electrical energy to acoustic energy which travels through the formation to one or more receivers. The receivers convert the acoustic wave back into an electrical impulse that can be measured.

- A **Temperature log** is obtained by lowering a temperature sensor down the water-filled borehole at a slow but constant rate. As water flows by the sensor, the temperature is recorded. The temperature probe should be slowly lowered through undisturbed formation water to ensure accuracy. In general, the geothermal gradient is greater in formations with high hydraulic conductivity than in formations with low hydraulic conductivity. This relationship is usually governed by the rate of groundwater flow. Thus, interpretation of thermal data can suggest the relative hydraulic conductivity of the formation in the borehole. Temperature logs are also used to detect episodes of seasonal recharge because recharge upsets the usual temperature regime. They are valuable in identifying heat-pump recharge water, excess irrigation and industrial wastes.

<u>Meteorological Factors</u>

Site-specific meteorological data are used when conducting screening or model analyses. Collection of meteorological data in the field requires the design of a system that provides the necessary input information for dispersion modeling and takes into account the logistics of siting and operation of meteorological stations. The following meteorological parameters are typically measured in the field:

- **Horizontal wind speed sensors** (anemometers) are available in many shapes and sizes. The most common types are the rotational cup and the propeller anemometers. The cup sensors are generally more accurate. The design of the anemometer cups dictates the durability, sensitivity, accuracy, and response of the instrument. Three conical cups usually provide the best performance. Propeller anemometers revolve about a pivoted shaft that is oriented by a vane into the direction from which the wind is blowing. The number of blades normally varies from three to six. For most atmospheric dispersion studies, anemometers should have a starting threshold of 0.5 meters per second or less and a system accuracy of ± 0.2 meters/sec.

Most sensors for measuring <u>horizontal wind direction</u> consist of a vane rotating on a fulcrum. The shapes and designs of the vane surface vary, but are generally rectangular or curved. The vanes are designed to orient into the direction from which the wind is blowing. For atmospheric dispersion studies, wind vanes should have a starting threshold of less that or equal to 0.5 m/s and a system accuracy of ± 5 degrees.

- **Vertical wind speed and direction** can be measured with a vertical propeller anemometer, a UVW anemometer, or bivane. The vertical propeller anemometer has a propeller-type sensor mounted on a fixed vertical shaft. Since the propeller can reverse its direction, the sensor can indicate whether wind flows are directed upward or downward. The UVW anemometer is located on a vertical shaft at right angles to the first two shafts. This anemometer will measure the total (i.e., U and V are the horizontal wind components and W is the vertical wind component) wind vector. The UVW anemometer can be assembled to give real time data, including wind speed, azimuth, and elevation. The bivane consists of a vane with two flat plates perpendicular to each other and mounted so as to allow rotation horizontally and vertically. It only provides azimuth and elevation components of the wind direction and, therefore, must be complemented with a propeller anemometer.

The most common devices used to measure ambient temperature are resistive temperature detectors (RTDs) and thermistors. Thermistors are electronic semiconductors that are made from certain metallic oxides. The resistance of the thermistor varies inversely with its absolute temperature, so the electrical output through the sensor can provide an indication of the ambient temperature. The RTD, which functions in a similar manner, are made of different pure metals including silver, copper, nickel, or platinum. Normally, platinum provides the best material. The RTD measures the electrical resistance of a pure metal, which increases with temperature.

- **Cloud cover** is best determined from data collected at a representative National Weather Service (NWS) Station as there are trained observers available to provide this information. If representative NWS cloud cover data are not available, then the total amount of cloudiness above the apparent horizon should be estimated as a fraction (in tenths) by a visual observation.

- **Ceiling height** is defined as a layer of clouds that covers more than one-half of the sky. The height of a ceiling is best determined by experienced observers at NWS Stations. It can be estimated visually at the waste site by determining the height of the lowest layer of clouds that cover more that 50 percent of the sky. A pocket-sized cloud atlas may be a useful tool for the field observer.

- **Mixing heights** are best determined from representative NWS Stations that record upper air (i.e., above the surface) data. Instrumentation packages called radiosondes are carried aloft twice daily (7:00 a.m. and 7:00 p.m. EST) throughout the United States by nontethered balloons. These packages measure wind speed and direction, temperature, and humidity as they ascend. Estimates of the mixing height can also be made at the site through the use of balloonsondes (tethered and nontethered balloons) and with remote sensors such as acoustic sounders. This equipment requires special expertise to use, to evaluate, and to apply the collected data.

- **Atmospheric stability** is determined in the field by using a number of alternative methods. These methods use the applicable meteorological parameters discussed above. The Pasquill-Turner method of classifying atmospheric stability uses the combination of wind speed, incoming solar radiation, cloud cover, and time of day.[4] The Pasquill-Turner equation is as follows:

$$\sigma_E = \sigma_W/US$$

Where σ_E = standard deviation of the vertical wind direction fluctuations
σ_W = standard deviation of the vertical wind speed fluctuations
US = scalar mean wind speed

It should be noted that σ_E in this discussion is in radian measure.

Streams and Rivers Contamination

Monitoring surface water contamination is accomplished through analysis of water samples collected from streams, lakes, or ponds. Baseline conditions, which provide a basis for comparison, can be determined by collecting samples from nearby or upstream surface waters that are known to be free of contaminants. Surface water samples are subjected to chemical analysis for constituents of interest, with temporal changes in the chemistry of a given location providing information regarding the contamination event. Evaluating changes in surface water chemistry requires knowledge of changes in related factors such as stream discharge, subsurface currents, water temperature, and water stratification.

Samples from shallow depths in rivers or streams can be collected by submerging the sample container. High waterproof boots can be worn by a technician when collecting a sample in small streams. A boat is required to collect samples in large rivers. The sample container is usually disposable or constructed of a nonreactive material such as glass, stainless steel, or Teflon. A weighted-bottle sampler is used to collect samples at any predetermined depth from lakes or reservoirs. The sampler consists of a glass bottle, a weighted sinker, a bottle stopper, and a line that is used to open the bottle and to lower and to raise the sampler during sampling. Teflon bailers have also been used where feasible to collect samples in deep bodies of water. Near-shore sampling may be performed using a pond sampler. A dipper can be used to collect grab samples from the top few inches of the water column. A Teflon or stainless steel dipper is used to collect a water sample, which is transferred to a sample bottle. Another method of sampling requires the use of a peristaltic pump. The pump can be attached to a long arm, allowing the sample to be pumped directly into the sample container. This system allows the operator to reach into the liquid body, sampling from depth, or sweeping the width of narrow streams.

pH Meters. The pH of a liquid can be determined in numerous ways. For scientific purposes, pH is always measured with a pH meter equipped with an appropriate electrode. These meters are generally accurate to 0.01 to 0.05 pH units. Another common method uses acid-base indicators that undergo color change over a rather narrow pH range. A universal indicator (pH paper), made by combining several acid-base indicators, may be used to determine pH (within one unit) of any liquid. Measurements of pH are also used in groundwater contamination studies.

Electrical Conductivity Meter The electrical conductance of a substance is its ability to conduct an electrical current. Current flows in ionized or mineralized water because the ions are electrically charged and move toward a current source that will neutralize them. The electrical conductivity meter uses a probe to measure this current flow. Liquids with greater conductivity usually indicate the presence of metals, salts, or other contaminants. Chemically pure water has a very low electrical conductance, indicating that it is a good insulator. Only a small amount of dissolved mineral matter will increase the conductance of the water. Conductance is measured in the inverse of ohms (the unit of resistance). Conductivity units are recorded as mhos and water conductance is usually expressed as micromhos. Electrical conductivity is also measured in groundwater contamination studies.

A **Current Meters** is a mechanical device with a rotating element that, when submerged in a flowing stream, rotates at a speed proportional to the velocity of the flow at that point below the surface. The rotating element may be either a vertical shaft or a horizontal shaft. Meter manufacturers usually provide the user with calibration tables to translate rotation into linear speed in meters or feet per second. Current meters can also be electromagnetic sensors where the passage of fluids between two electrodes in a bulb-shaped probe causes a disturbance of the electromagnetic field surrounding the electrodes. This disturbance generates a small voltage that can be made proportional to fluid velocity by internal electronic circuitry. A direct readout of velocity in meters or feet per second is provided for the user.

Stage Gauges Where repeated measurements of a volumetric flowrate at a certain cross-sectional area are required, it is best to install a permanent stage gauge along the stream's side wall to facilitate measurement of the depth. The gauge is usually made of rigid rod or board, with graduated markings on it and firmly mounted with the streambed serving as a possible reference point. Discharge rating curves can be used to define the relationship between stage and stream discharge, and to allow conversion of stage hydrographs to discharge hydrographs.

Weirs are commonly used flow measurement devices. They are relatively easy to install and inexpensive to construct. All weirs are deliberate restrictions inserted into an open channel or partially full pipe to obstruct flow by forcing the water through a calibrated cross section. The weir causes water to back up and create a higher level (head) than the level below the barrier. The height of that head is a function of the velocity of the flow. Standard tables and nomographs are available for many different types of weirs, based on different general equations for each type. The three most common weir configurations are triangular (or V-notch), rectangular, and Cipolletti (or trapezoidal).

Soil and Sediment Contamination

Sediments near shore or above the waterline are most easily collected using simple tools, such as polypropylene scoops, trowels, or dippers. Other alternatives for small semi-solid sediments include wooden tongue depressors or stainless steel tablespoons. For stream bottom sediment samples, vertical pipe or core samplers (hand corers, gravity corers) are driven into a stream bed to any selected depth. Ponar grab samplers are a clamshell-type scoop activated by a counter-lever system. The shell is opened, latched in place, and slowly lowered to the bottom. When tension is released on the lowering cable, the latch releases and the lifting action of the cable on the level system closes the clamshell.

Split-spoon and thin-walled (Shelby tube) samplers are used to collect intact samples of unconsolidated materials. Both techniques provide a continuous sample that is amenable to lab testing for permeability, density, and other parameters. Split-spoon samplers are attached to the end of a drill stem and are driven into the base of an open, clean borehole by a series of blows. Thin-walled samplers are similar, but are pressed into the subsurface using the weight of the drill rig to collect a less disturbed sample. Split-spoon and thin-walled samplers commonly are used in conjunction with hollow-stem augers.

Soil gas samples can be collected by either burying an adsorbent (e.g., activated charcoal) which remains undisturbed for a period of days to weeks. The adsorbent is retrieved and thermally or chemically desorbed, with the organic contaminants analyzed by mass spectrometry or gas chromatography. Soil gas grab samples can be taken by inserting a hollow metal probe into the vadose zone and withdrawing gas using a pump. Samples are analyzed on-site using portable instruments, providing real-time data.

Organic soil-gas analyzers are used to detect contaminant plumes transported with shallow groundwater. Organic compounds with high vapor pressures and low water solubilities will volatilize as a contaminant plume migrates, leaving detectable traces in vadose zone soils. Measurements of soil-gas can be made using a probe mounted on a truck, in situ (leaving a sampler in place), or by collecting a soil sample from which the gas is removed. The gas is analyzed using an organic vapor analyzer, photoionization detector, or gas chromatograph either with field instruments, in a mobile field lab, or in a fixed remote lab.

Soil resistivity surveys can provide information about aquifer boundaries, depth to water or bedrock, changes in soil type, and levels of contamination. The survey is conducted by driving a series of metal stakes (electrodes) into the ground at fixed spacing and in a straight line and supplying current to two electrodes using a battery or small generator (the current is measured with a current meter). The voltage between the other electrodes is measured with a voltage meter and the resistivity computed from these values.

Permeameters are used to measure the permeability of soil or rock samples in the lab. The devices have a sample chamber (typically cylindrical), a mechanism for forcing water through the sample, a device to measure hydraulic head, and a meter to determine discharge. Hydraulic conductivity is computed from a modification of Darcy's law. Two types of devices are used: constant head permeameters commonly are used for nonconsolidated or poorly cohesive samples, whereas falling head permeameters typically are used for cohesive sediments.

Wildlife Contamination

General collection of terrestrial **vertebrates** will document the presence of species and can be used to estimate population sizes. Vertebrate collection can be used to gather tissue for pollutant analysis.

Live traps are preferred to collect sensitive species when lethal traps or hunting are inappropriate. Population sizes can be estimated using live traps in a mark-and-recapture context. A list of species present on the site can be generated. The size of the range can be estimated using marking or radiotelemetry after capture and release. Animals can also be trapped alive to collect tissue (especially blood) for analysis.
Lethal trapping can be used to establish which species are present on a site and to collect tissue-donor specimens for analysis of pollutants.

Hunting allows the documentation of species present on the site and is suitable for collecting tissues for analysis. It is most useful on medium- to large-sized species and may be best for species not susceptible to trapping.

Ecological analysis provides an integrated analysis of the habitat values on a site. The impact of the pollution on the site's most important habitat values can be assessed by using an uncontaminated comparison area or information on a polluted site before it was polluted.

Macroinvertebrates can be sampled using sediment grabs, core samplers, shovels, box sieves, surber samplers, invertebrate drift nets, traps (i.e., lake bottoms for crayfish), artificial substrates, in-situ bioassays, and other miscellaneous methods (i.e, hands, hand tools, dip nets, plankton nets).

Methods for collecting fish samples include trawls, electrofishing, seining (large net fishing), hook and line, and miscellaneous (e.g., gill, nets, trammel nets, fyke nets, or rotenone) methods.

c. Discuss the following techniques of sampling and monitoring the environment:

- Analytical laboratory vs. field techniques
- Well drilling
- Geophysical or non-intrusive methods

Analytical Laboratory vs. Field Techniques

In general, laboratory analyses are considered to be more rigorous because they have lower detection limits, are more accurate, and a greater variety of analyses are available. Laboratory analyses also require a rigorous quality assurance (QA) and quality control (QC) process. A drawback to laboratory analysis is the difficulty in preserving sample integrity from the moment of collection until the time of analysis. Field analyses are valuable because they are cheaper, can provide information quickly (in some cases in real time), and are conducted in situ, minimizing sample integrity concerns. Field samples, however, may not meet the QA/QC requirements of Federal or state laws.

Well drilling

Subsurface samples can be collected at discrete intervals as a borehole is advanced. Common sampling methods include split-spoons, Shelby tubes, core barrels, and drill cuttings. Indirect analyses includes downhole wireline geophysical logging methods such as spectral gamma ray logs, neutron probe logs, among many others. Subsurface sampling provides information about the vertical and horizontal extent of contamination and details of local lithology.

Important hydrogeologic information can be obtained by well drilling, including: (1) Stratigraphic information concerning the aquifer and overlying sediments (2) Transmissivity and storage coefficient values for the aquifer, (3) Current and long-term water balance conditions of the aquifer, (4) Grain-size analyses of unconsolidated aquifer materials and identification of rock and mineral types, if necessary, and (5) Water quality. Detailed information on various drilling techniques is presented by Driscoll (1986).

Geophysical or non-intrusive methods often show anomalies, which may help to identify waste sites and plumes of contaminated groundwater. See Section b above for information on specific geophysical methods.

d. Describe the various analytical and validation methods. Include in the discussion the protocols used and the purpose of a Quality Assurance Project Plan.

Common analytical methods are specified in EPA's SW-846, Test Methods for Evaluating Solid Waste, and in EPA's Contract Laboratory Program (CLP) procedures. EPA has also specified data validation guidelines in “Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses” and “Laboratory Data Validation Functional Guidelines for Evaluating Organics Analyses”.

A Quality Assurance Project Plan (QAPP) describes the objectives of a project and the procedures to be followed to ensure that the data generated will serve those objectives. The plan serves to focus the planning process and to promote communication among the staff responsible for implementing the project.

The QAPP is developed to identify the organization, function, and staff; to delineate responsibilities for quality assurance; to define the quality control processes that will be implemented in the performance of tasks associated with the project; and to ensure that the project meets target standards based upon precedents and policies.

Two primary factors affect environmental data quality: measurement uncertainty and sample uncertainty. Implementing quality control measures and quality assurance procedures can minimize the concerns associated with each factor. Quality control measures include the adoption of good laboratory habits and practices, institution of standard sampling procedures, and the use of sound sample preparation and analytical procedures. Sampling protocols should be developed specifically for the problem under consideration and should be strictly followed.[1] Sample collection technicians must be properly trained in the approved procedure, sampling equipment must be calibrated per established schedules, samples must be protected from destabilization, sample containers must be properly identified, and chain-of-custody procedures must be precisely followed.[1]

Quality assessment requires monitoring of the sampling and analysis processes, and is best accomplished through continuous auditing. Sampling protocols should be carefully examined on a periodic basis. The EPA requires a QAPP and the inclusion of five data quality indicators (DQIs) (precision, bias, representativeness, completeness, and comparability) to control data quality. Data quality objectives (DQOs) are derived from the QAPP (and its objectives for DQIs), and indicate the level of uncertainty that is acceptable based on the intended use of the data.

[1] Keith, Lawrence H. (Editor), *Principles of Environmental Sampling*, Salem, MA, American Chemical Society, 1988.
[2] Godish, T., *Air Quality*, 2nd Edition, Lewis Publishers, Chelsea, MI, 1991.
[3] Driscoll, F., *Groundwater and Wells*, 2nd ed., Johnson Division, St. Paul, MN, 1986.
[4] *U.S. EPA, Evaluation Guidelines for Toxic Air Emissions from Land Disposal Facilities*. Washington DC, Office of Solid Waste, August 1981.

1.14 *Environmental restoration personnel shall demonstrate a working level knowledge of the principles, concepts, and requirements of an environmental risk assessment.*

The 1990 National Contingency Plan (NCP) [55 Fed. Reg. 8665-8865 (Mar. 8,1990)][1] calls for a site-specific baseline risk assessment to be conducted as part of the remedial investigation. Specifically, the NCP states that the baseline risk assessment should "characterize the current and potential threats to human health and the environment that may be posed by contaminants migrating to groundwater or surface water, releasing to air, leaching through soil", [Section 300.430 (d)(4)]. The primary purpose of the baseline risk assessment is to provide both managers, regulators, and the public with an understanding of the actual and potential risks to human health and the environment posed by the site and any uncertainties associated with the assessment. This information is used to determine whether a current or potential threat to human health or the environment exists that warrants remedial action.[2] The two components of the baseline risk assessment then, are the human health risk assessment (HHRA) and the ecological evaluation (EE).

The *Risk Assessment Guidance for Superfund:Volume I, Human Health Evaluation Manual - Part A*,[3] provides guidance and outlines methodologies and approaches suggested by EPA in conducting the human health portion of the baseline risk assessment. Volume II of the *Risk Assessment Guidance for Superfund, the Environmental Evaluation Manual*,[4] and the companion manual, *Biological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*,[5] provides guidance on conducting the environmental portion of the baseline risk assessment. Other pertinent guidance includes the *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA*,[7] which describes how the baseline risk assessment fits into the overall Remedial Investigations and Feasibility Studies (RI/FS) process.[2]

The objectives of the human health risk assessment are to

- Provide an analysis of baseline risks and help determine the need for action at sites;
- Provide a basis for determining levels of chemicals that can remain onsite and still be adequately protective of public health;
- Provide a basis for comparing potential health impacts or various remedial alternatives; and,
- Provide a consistent process for evaluating and documenting public health threats at sites.[3]

The ecological evaluation is a qualitative and/or quantitative appraisal of the actual or potential effects of a hazardous waste site on plants and animals. The ecological evaluation is an essential element in determining overall risk and protecting public health, welfare, and the environment.

Human health risk assessments and ecological assessments are different processes. It is important to emphasize, however, that the health of people and domestic species is linked to the quality of the environment shared with other species. Information from ecological studies may point to new or unexpected exposure pathways for human populations, and health assessment may help to identify environmental threats.

Ecological and human health evaluations are usually parallel activities in the evaluation of hazardous waste sites. Much of the data and analyses relating to the nature, fate, and transport of a site's contamination will be used in evaluations. Analysts should be sensitive to the possibility that certain contaminants and exposure pathways may be more important for the ecological evaluation than for the human health evaluation, or vice versa. It is also important to recognize that each of the two evaluations can sometimes make use of the other's information. For example, the potential of a chemical or contaminant to bioaccumulate may be estimated for a human health evaluation but be useful for the ecological evaluation. Similarly, measurements for containment levels in sport and commercial species for an ecological evaluation may yield useful information for the human health evaluation.

<u>Supporting Knowledge and/or Skills</u>

a. Define risk assessment, risk management, and risk communication.

Risk assessment is a complex process by which the harm that a substance can have on human health or the environment is quantified. Risk assessment determines if there is a health or environmental risk, what the risk is, and how severe the risk is. With respect to human health, a risk assessment begins with the identification of specific hazards associated with the substance(s) of concern, examination of the dose-response patterns, human exposure considerations, and results in a risk characterization that is quantitative and qualitative in nature. Risk assessment provides the data necessary for making decisions by providing better problem definition in the form of probabilities or estimates of impact on human health and the environment.

Risk management is a determination of what to do about a risk; typically, after the risk is evaluated in the Risk Assessment. Risk management entails a systematic, comprehensive approach to decision-making contingent on the control of impacts associated with a specific activity. Risk management involves risk reduction, and the identification and understanding of the relationship between programmatic, regulatory, policy, and financial actions and decisions. Risk Management, therefore, is the integration of this information to result in a decision. Risk management requires the collection and assessment of information about cleanup alternatives and includes the evaluation and integration of stakeholder input into the decision-making process.

Risk Communication evolved out of the need of risk managers to gain public acceptance for policies grounded in risk assessment methodologies. Risk communication describes a wide range of activities. Typically it refers to any public or private communication that informs individuals about the existence, nature, form, severity or acceptability of risk.[8]

b. ***Describe the four steps of a risk assessment.***

Risk assessment provides a mechanism for determining whether or not a corrective action needs to be undertaken at a contaminated site and if a violation of environmental regulations has actually occurred.[9]

The four elements of a risk assessment are hazard identification, toxicity assessment, exposure assessment, and risk characterization.

Hazard identification requires a qualitative assessment of the presence of a contaminant and the degree of threat present. Selection of contaminants which represent the greatest majority of risk to the site requires identification of the source(s) of contaminants, selection of the contaminants of concern (based on hazardous properties), and compilation of statistics in support of further evaluative efforts.[8]

The **toxicity assessment** involves the acquisition of toxicity information and dose-response evaluation. The toxicity assessment is concerned with determination of the harmful effects of exposure and the adverse effects associated with specific levels of exposure. The toxicity assessment requires compilation of toxicological profiles, with dose-response relationships being examined to aid in the estimation of adverse effects to be expected in populations exposed to different levels of the contaminant.[8]

The **exposure assessment** is undertaken to estimate the degree of potential or actual exposure of a population to the contaminant of concern. It includes estimates of frequency and duration of exposure, "exposed" population data, and exposure pathways for population groups. Exposure estimates provide the necessary data to evaluate if a threat exists based on conditions at or near the contamination site.[8]

Risk characterization entails the estimation of the probable incidence of harmful effects to the potential population at risk under various conditions of exposure. The risk characterization phase integrates and summarizes the results of the toxicity and exposure assessments to define quantitative and qualitative risk levels. Risk characterizations include descriptions of the level of certainty of the data. Risks can be prioritized according to the severity of the risk, leading to a more focused and effective corrective action.[8]

c. ***Discuss the part risk assessment plays in the following:***

- Pre-remedial program
- Removal program
- Remedial program

Pre-remedial programs require the establishment of preliminary remediation goals (PRGs) to define cleanup objectives early in the site characterization process, to facilitate the development of corrective action alternatives, and to aid in the selection of the most effective remedial action. EPA (1991b)[10] describes the process of developing PRGs. The development of PRGs requires extensive site specific information regarding the contaminant impacts to environmental media; risk assessment data provide this information. Risk assessment data are critical to the execution of removal actions and remedial actions, as both of these response actions require site specific information regarding contaminants, associated hazards, and avenues of potential dispersion. This information is necessary to plan cleanup actions and to protect the public health and safety during the cleanup actions.

Removal Programs require that the magnitude of the threat to human health and the environment by a release be evaluated. Evaluation of the risk will determine if a removal action is necessary. Usually for a removal action to be required, the potential of release or threat of release must be significant. Then the removal action is performed to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or threat of release from a site. The risk evaluation usually considers the exposure to human populations, animals, or the food chain from a release. Potential threats to drinking water supplies, sensitive ecosystems, high levels of hazardous substances, weather conditions that may cause migration of contaminants, threat of fire or explosion, and the ability of Federal or state agencies to respond to a release are also considerations evaluated for a removal action. Removal actions must be designed to contribute to the efficient performance of any anticipated long-term remedial action with respect to the release of concern.

Remedial Programs require that the magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the implementation of remedial activities be assessed. The associated risk after a remedial program has been completed must meet the standards agreed to and specified in the Record-of-Decision. The characteristics of the residuals must be considered to the degree that they remain hazardous, taking into account their volume, toxicity, mobility, and propensity to bioaccumulate after remediation.

d. ***Describe how risk assessment helps in site decision-making.***

As discussed in 4.14(b), the results of a risk assessment provide the information necessary to determine if a corrective action needs to be initiated at a site and whether or not environmental regulations have been violated. Cleanup criteria, based on an acceptable benchmark risk level for the specific conditions experienced, can be derived as a result of the risk assessment. Risk assessment can indicate where resources should be applied to gain the maximum benefit from the corrective action.[8]

e. Define the term "baseline risk assessment".

A **baseline risk assessment** is an analysis of current and future potential adverse health and environmental effects resulting from the release of a hazardous substance at a specific site and in the absence of any corrective action. A baseline risk assessment identifies the primary health and environmental threats presented by the site and provides data for the development and evaluation of site-specific alternative restoration plans. Baseline risk assessments contribute to the site characterization process by providing information regarding the necessity of undertaking a remedial action.[8]

f. Describe the process for performing a toxicity assessment.

A toxicity assessment consists of a hazard assessment and a dose-response assessment. A hazard assessment requires the compilation of toxicological profiles for the substances of concern. In conjunction with the hazard assessment, a dose-response evaluation is used to determine the effects of various doses of a contaminant and the incidence of adverse effects on the exposed population. Risks associated with a contaminant cannot be adequately characterized without quantifying the potential effects through a dose-response assessment, even if the substance is known to be toxic. The toxicant is evaluated to determine the degree of morbidity/lethality to be expected at various exposure levels, the mechanism of action, metabolization, bioaccumulation, and other factors.[8]

The steps in a toxicity assessment include: 1) gather toxicity information, both qualitative and quantitative, for substances being evaluated; 2) identify exposure periods for which toxicity values are necessary; 3) determine toxicity values for noncarcinogenic effects; 4) determine toxicity values for carcinogenic effects; and, 5) summarize toxicity information.[3]

<u>Gathering data</u>. Evidence should be gathered from a variety of sources regarding the potential for a substance to cause adverse health effects (carcinogenic and noncarcinogenic) in humans. These sources may include controlled epidemiologic investigations, clinical studies, and experimental animal studies. Supporting information may be obtained from sources such as in vitro test results and comparisons of structure-activity relationships.[3]

<u>Exposure Periods</u>. Identification of the exposure periods for which toxicity values are necessary is usually performed in close consultation with the regulating agency’s toxicologist or risk assessor. The exposure period for one particular constituent (i.e., site specific contaminant) consists of the duration of the exposure in hours per day, the number of days per year, and the number of years in the expected average lifespan of the

exposed individual or population. The terms used in risk assessment for exposure are chronic, subchronic, and single event.[3]

<u>Toxicity Values for Noncarcinogenic Effects</u>. A reference dose, or RfD, is the toxicity value used most often in evaluating noncarcinogenic effects resulting from exposures at a site. Various types of RfDs are available depending on the exposure route (oral or inhalation), the critical effect (developmental or other), and the length of exposure being evaluated (chronic, subchronic, or single event). Also important in determining toxicity values is establishing the effect of a constituent characterized by the "lowest-observed-adverse-effect-level" (LOAEL) which is referred to as the critical toxic effect. The NOAEL (no-observed-adverse-effect-level) is established after the LOAEL and represents the highest level tested at which no adverse effects - including critical toxic effect - were demonstrated. The NOAEL is the key datum obtained from the study of the dose-response relationship.[3]

<u>Toxicity Values for Carcinogenic Effects</u>. For carcinogenic effects, a slope factor and the accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. Important to the evaluation of carcinogenic effects is the assumption made by EPA that a small number of molecular events can evoke changes in a single cell that can lead to uncontrolled cellular proliferation and eventually to a clinical state of disease. This mechanism for carcinogenesis is referred to as "nonthreshold" because there is believed to be essentially no level of exposure to such a chemical that does not pose a finite probability of generating a carcinogenic response. Due to nonthreshold effects, EPA uses a two-part evaluation in which the substance first is assigned a weight-of-evidence classification, and then a slope factor is calculated. The two-part evaluation is complex and detailed and the reader is referred to EPA guidance documents for the methodology.[3] Moreover, for some chemicals, toxicity values have not been developed These chemicals must go through an additional toxicity development process as detailed by EPA.[3] Lastly, for all toxicity values there is inherent uncertainty in the values and this fact must be taken into consideration when developing and using these values.[3]

<u>Summarization of Toxicity Information</u>. EPA suggests, through guidance documents, methods for presenting toxicity information. A short description of the toxic effects of each chemical carried through the assessment in non-technical language should be prepared for inclusion in the main body of the risk assessment. The database and the study from which particular data were taken should be indicated. Summary tables should be used extensively. They should include RfDs, uncertainty factors, confidence ratings, and a notation of the critical effects of any particular chemical. Slope factors should always be accompanied by EPA's weight-of-evidence classification.[3]

g. Describe the process for performing an exposure assessment.

An exposure assessment is performed to estimate the severity of actual/potential exposures to contaminants, the duration and frequency of the exposures, and the size and nature of the population at risk. An assessment for human health risks requires characterization of the physical setting and exposure settings of the site, identification of exposure pathways and migration pathways, identification of potential receptors, analysis of contaminant fate and transport, estimation of exposure point concentrations for environmental media and for critical pathways, and estimation of chemical intakes for significant pathways of concern and all potential receptors. Exposure assessments may employ modeling of future anticipated exposures, environmental monitoring of present exposures, and biological monitoring for the determination of past exposures.[8]

The general procedure for conducting an exposure assessment includes: 1) characterization of exposure setting; 2) identification of exposure pathways; and 3) quantification of exposure. The detailed exposure assessment process begins after the chemical data have been collected and validated and the chemicals of potential concern have been selected.[3]

<u>Characterization of Exposure Setting</u>. In this step, the risk assessor characterizes the exposure setting with respect to the general physical characteristics of the site and the characteristics of the populations on and near the site. Basic site characteristics such as climate, vegetation, groundwater hydrology, and the presence and location of surface water are identified and described with respect to those characteristics that influence exposure, such as location relative to the site, activity patterns, and the presence of sensitive subpopulations. This step considers the characteristics of the current population, as well as those of any potential future populations that may differ under an alternate land use.[3]

<u>Identification of Exposure Pathways</u>. This step identifies those pathways by which the previously identified populations may be exposed. Each exposure pathway describes a unique mechanism by which a population may be exposed to the chemical of concern. Exposure pathways are identified based on consideration of the sources, releases, types, and locations of chemicals at the site; the likely environmental fate (including persistence, partitioning, transport, and intermedia transfer) of these chemicals; and the location and activities of the potentially exposed populations. Exposure points (points of potential contact with the chemical) and routes of exposure (e.g., ingestion, inhalation) are identified for each exposure pathway.[3]

<u>Quantification of Exposure</u>. In this step, the assessor quantifies the magnitude, frequency and duration of exposure for each pathway identified. This step is most often conducted in two stages: estimation of exposure concentrations and calculation of intakes.[3]

Estimation of Exposure Concentrations. The risk assessor determines the concentration of chemicals that will be contacted over the exposure period. Exposure concentrations are estimated using monitoring data and/or chemical transport and environmental fate models. Modeling may be used to estimate future chemical concentrations in media that are currently contaminated or that may become contaminated, and current concentrations in media and/or at locations for which there are no monitoring data.[3]

Calculation of Intakes. The risk assessor calculates chemical-specific exposures for each exposure pathway identified above. Exposure estimates are expressed in terms of the mass of substance in contact with the body per unit body weight per unit time. These exposure estimates are termed “intakes” and represent the normalized exposure rate. Chemical intakes are calculated using equations that include variables for exposure concentration, contact rate, exposure frequency, exposure duration, body weight, and exposure averaging time. The values of some of these variables depend on site conditions and the characteristics of the potentially exposed population. After intakes have been estimated, they are organized by population, as appropriate.[3]

Reasonable Maximum Exposure. Action at Superfund sites should be based on an estimate of the reasonable maximum exposure (RME) expected to occur under both current and future land-use conditions. The RME is defined as the highest exposure that is reasonably expected to occur at a site. RMEs are estimated for individual pathways. If a population is exposed via more than one pathway, the combination of exposures across pathways also must represent an RME. Estimates of the RME necessarily involve the use of professional judgment. In addition, RMEs are very site-specific and are usually developed in close consultation with the regulatory agencies. Exposures generally are estimated for an average and an upper-bound exposure case, instead of a single exposure case. The advantage of the two case approach is that the resulting range of exposures provides some measure of the uncertainty surrounding these estimates. The disadvantage of this approach is that the upper-bound estimate of exposure may be above the range of possible exposures, whereas the average estimate is lower than exposures potentially experienced by much of the population.[3]

h. Describe the process used to characterize risk.

Risk characterization is the final step in the development of the Baseline Risk Assessment process. Risk characterization estimates the probable incidence of adverse effects to potential receptors under a variety of exposure scenarios. Risk characterization summarizes and integrates the results of exposure and toxicity assessments to define risk levels. Risk characterization requires the comparison of chemical-specific toxicity data against field-measured and estimated contaminant exposure levels to determine if contaminant concentrations are of concern. The level of risk of an exposed population is characterized by calculating noncarcinogenic hazard quotients and indices, and carcinogenic risks (if applicable); and evaluating these parameters against benchmark standards, so that risk decisions can be made for the site. Risk characterization considers the effects of single chemicals as well as the synergistic effects due to multiple chemical interactions (when known) and adjusts for those effects. A risk characterization cannot be considered complete unless the numerical expressions of risk are accompanied by explanatory text interpreting and qualifying the results.[3]

Review of Outputs from the Toxicity and Exposure Assessments. Most sites will require the evaluation of more than one chemical of concern and might include both carcinogenic and noncarcinogenic substances. The first step in risk characterization is to gather, review, compare, and organize the results of the exposure assessment and toxicity assessment.[3]

Gather and Organize Information. For each exposure pathway and land use evaluated in the exposure assessment, check that all information needed to characterize risk is available.[3]

Make Final Consistency and Validity Check. Check the consistency and validity of key assumptions common to the exposure outputs and the toxicity outputs for each contaminant and exposure pathway of concern. These assumptions include the following:

- Averaging period for exposure - If toxicity value is based on average lifetime exposure, then the exposure duration must also be expressed in those terms.

- Absorption adjustment - Check that the exposure estimates and the toxicity values are either both expressed as absorbed doses or both expressed as intakes. The three types of absorption adjustments that might be necessary or appropriate depending on the available toxicity are: 1) dermal exposures; 2) absorbed-dose toxicity value; and, 3) adjustment for medium of exposure.[3]

Quantifying Risks. The next step is to quantify risk or hazard indices for both carcinogenic and noncarcinogenic effects. The indices are applied to each exposure pathway analyzed. The following steps must be calculated:[3]

- Calculate risk for individual substances
    - carcinogenic effects
    - noncarcinogenic effects

- Aggregate risks for multiple substances
    - carcinogenic effects
    - noncarcinogenic effects
    - segregation of hazard indices

Combining Risks Across Exposure Pathways. This step involves the combining of the multi-chemical risk estimates across exposure pathways and determining when such aggregation is appropriate. At some sites, an individual might be exposed to a substance or combination of substances through several pathways. The total exposure to various chemicals will equal the sum of the exposures by all pathways. The steps for combining risks are as follows:[3]

- Identify reasonable exposure pathway combinations;
- sum cancer risks; and,
- sum noncancer hazard indices.

Assessment and Presentation of Uncertainty. Uncertainty in Superfund site risk assessments must be performed in order to present key information bearing on the level of confidence in quantitative risk estimates for a site. The following steps are needed to summarize and discuss important site-specific exposure uncertainties and the more general toxicity assessment uncertainties[3]:

- Identify and evaluate important site-specific uncertainty factors:
  - definition of the physical setting;
  - model applicability and assumptions;
  - parameter value uncertainty; and,
  - tracking uncertainty.

- Identify and evaluate toxicity assessment uncertainty factors:
  - multiple substance exposure uncertainties.

Consideration of Site-Specific Human Studies. This step compares the results of the risk characterization with the Agency for Toxic Substances and Disease Registry (ATSDR) health assessments and other site-specific human studies that might be available. These types of studies include not only the ATSDR health assessments, but also any epidemiological or health studies that might provide useful information for assessing exposures and health risks associated with contaminants from a site.[3]

Summarization and Presentation of the Baseline Risk Characterization Results. The results of the risk characterization should not be taken as a characterization of absolute risk. An important use of the risk and hazard index estimates is to highlight potential sources of risk at a site so that they may be dealt with effectively in the remedial process. Basically, the information should be presented in text and table format. The discussion provides a means of placing the numerical estimates of risk and hazard in the context of what is known and what is not known about the site, and in the context of decisions to be made about the selection of remedies. At a minimum, the discussion should include[3]:

- confidence that the key site-related contaminants were identified and discussion of contaminant concentrations relative to background concentration ranges;
- a description of the various types of cancer and other health risks present at the site, distinguishing between known effects in humans and those that are predicted to occur based on animal experiments;

- level of confidence in the quantitative toxicity information used to estimate risks and presentation of qualitative information on the toxicity of substances not included in the quantitative assessment;
- level of confidence in the exposure estimates for key exposure pathways and related exposure parameter assumptions;
- the magnitude of the cancer risks and noncancer hazard indices relative to the Superfund site remediation goals in the NCP;
- the major factors driving the site risks (e.g., substances, pathways, and pathway combinations);
- the major factors reducing the certainty in the results and the significance of these uncertainties;
- exposed population characteristics; and,
- comparison with site-specific health studies, when available.

The results of the risk characterization step should be summarized in a few succinct concluding paragraphs. The discussion should summarize both the qualitative and the quantitative findings of cancer risks and noncancer hazards, and properly qualify these by mention of major assumptions and uncertainties in the assessment.[3]

i. Describe methods for performing pathway modeling. Include in the discussion the advantages and disadvantages of each method.

Numerous models exist for pathway modeling. Models may be for a specific environmental media; for example air, groundwater, or multimedia. Models are developed for specific outcomes, i.e., calculation of short-term ground level pollutants or predicting contaminant transport. The choice of one particular model over another will generally be problem-specific and media specific.

A detailed discussion of these modeling methods is beyond the scope of this study guide. A listing of environmental models applicable to pathways modeling appears in Asante-Duah.[8] The table includes the model title, media, description, uses, and sources of information. This list is comprehensive, but not exhaustive.

j. Perform an environmental risk assessment.

This is a demonstration skill and an individual will actually be performing the activity rather than acknowledging comprehension. Information for this topic is located in the above sections and the references listed in the introductory paragraph of this section.

Baseline risk assessments are site-specific and, therefore, may vary in both detail and the extent to which qualitative and quantitative analyses are used, depending on the complexity and particular circumstances of the site, as well as the availability of applicable or relevant and appropriate requirements and other criteria, advisories, and guidance.

[1] EPA, 1990, *National Oil and Hazardous Substance Pollution Contingency Plan*, Final Rule, 40 CFR Part 300, Federal Register, vol. 55, No. 46, March 1990.
[2] EPA, 1991a, *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, Office of Solid Waste and Emergency Response, OSWER Directive 9355.0-30, April 22, 1991.
[3] EPA, 1989a, *Risk Assessment Guidance for Superfund:* Volume I, Human Health Evaluation Manual - Part A, Interim Final, Office of Emergency and Remedial Response, EPA/540/1-89/002.
[4] EPA, 1989b, *Risk Assessment Guidance for Superfund:* Volume II: Environmental Evaluation Manual, Interim Final, Office of Emergency and Remedial Response, EPA/540/1-89/002.
[5] EPA, 1989c, *Ecological Assessment of Hazardous Waste Sites:* A Field and Laboratory Reference, Office of Emergency and Remedial Response, EPA/600/3-89/013.
[6] EPA, 1989d, *Guidance for Conducting Remedial Investigations and Feasibility Studies* Under CERCLA, Interim Final, Office of Emergency and Remedial Response, EPA/540/G-89/004, OSWER Directive 9355.3-01.
[7] EPA, 1989d, *Guidance for Conducting Remedial Investigations and Feasibility Studies* Under CERCLA, Interim Final, Office of Emergency and Remedial Response, EPA/540/G-89/004, OSWER Directive 9355.3-01.
[8] Plough, Alonzo, and Sheldon Krimsky, *The Emergence of Risk Communication Studies: Social and Political Context, Science Technology, and Human Values*, vol. 12, nos. 3 and 4. Summer/Fall, 1987.
[9] Asante-Duah, D. Kofi, *Management of Contaminated Site Problems*, Lewis Publishers, Boca Raton, FL 1996.
[10] EPA, 1991b, *Risk Assessment Guidance for Superfund:* Human Health Evaluation Manual (Part B, Development of Risk Based Preliminary Remediation Goals). Office of Emergency and Remedial Response, 1991.

2. REGULATORY

2.1 Environmental restoration personnel shall demonstrate a working level knowledge of the following National Environmental Policy Act (NEPA) documentation and its applicability to environmental restoration projects

- Implementation Plan (IP)
- Environmental Impact Statement (EIS)
- Environmental Assessment (EA)
- Finding Of No Significant Impact (FONSI)
- Categorical Exclusion (CX)
- Record of Decision (ROD)
- Mitigation Action Plan

Supporting Knowledge and/or Skills

a. Describe the process for developing the above listed documents. Include a discussion of the format used and any guidance available for each document.

The NEPA process is intended to help public officials make decisions that are based on understanding of environmental consequences, and take action to protect, restore, and enhance the environment. NEPA is a process and the document is evidence of that process.

NEPA ensures that the agency, in reaching its decision, will have available and will carefully consider detailed information concerning significant environmental impacts. NEPA also guarantees that the relevant information will be made available to the larger audience that may also play a role in both the decision making process and implementation of that decision.

NEPA applies to all Federal actions that may be considered "major" actions and which are subject to Federal control and responsibility. This includes actions that are partly or entirely financed, assisted, conducted, regulated, or approved by Federal agencies.

- **Implementation Plan (IP) – Table 2.1-1**

  The DOE regulations (10 CFR Part 1021.312) require DOE to prepare an Environmental Impact Statement (EIS) Implementation Plan (IP) to provide guidance for the preparation of the EIS and record the results of the scoping process. The DOE regulations mandate that an IP shall be completed as soon as possible after the close of the public scoping process and before the draft EIS is issued. This requirement will be eliminated from upcoming amendments to 10 CFR 1021. The CEQ regulations (40 CFR Parts 1500-1508) do not require an IP.

Table 2.1-1 **Implementation Plan**
The IP shall include: (1) Planned scope; (2) Purpose and need of proposed action; (3) Description of scoping process and the results; (4) Target schedules; (5) Anticipated consultation with other agencies; and (6) Disclosure statement executed by any contractor or subcontractor under contract with DOE to prepare the EIS in accordance with 40 CFR 1506.5(c).

The IP, at DOE's discretion, may include target page limits for the EIS and planned work assignments. DOE shall make the EIS IP and formal revisions available to the public.

- **Environmental Impact Statement (EIS) – Table 2.1-2**

  The EIS process is initiated by publishing a notice of intent (NOI) in the *Federal Register.* Publication of the NOI begins the scoping period (a minimum of 30 days) for receiving comments on the DOE's proposal to prepare an EIS and on the draft alternatives outlined in the NOI. At least one public scoping meeting is required during the scoping period. A written transcript of comments from EIS scoping activities and copies of written comments are made available, as soon as possible, in public reading rooms.

  Once the draft EIS is complete, a notice of availability is published and begins the period of at least 45 days for public review and comment. The draft EIS and appropriate related material will be made available in public reading rooms and mailed to interested groups and individuals upon request. At least one public hearing is conducted after the notice of availability is published. A summary of the comment process and the disposition of comments received on a draft EIS will be included in a Comment Response Document, which is also made available to the public as a part of the final EIS.

  The DOE will publish a notice of availability of the final EIS in the *Federal Register.* The DOE must wait 30 days after publication of the notice of availability before making a decision on the proposed action.

Table 2.1-2 **Environmental Impact Statement**
The following standard format should be followed (for EIS) unless the agency determines ther is a compelling reason to do otherwise (40 CFR 1502.10): (a) Cover sheet; (b) Summary of the document; (c) Table of contents; (d) Purpose of and need for action; (e) Alternatives, including the proposed action and no action; (f) Affected environment; (g) Environmental consequences of the proposed action and alternatives; (h) List of preparers; (ij) Index; and, (jk) Appendices.

10 CFR 1021, Appendix D, Subpart D lists the type of actions that normally require an EIS. These include: siting/construction/expansion of waste disposal facilities for transuranic waste; siting/construction/operation of high-level waste treatment , storage, or disposal facilities; and Major Systems Acquisitions, as designated by DOE Order 4240.1.

- **Environmental Assessment (EA) – Table 2.1-3**

An EA is a concise public document that serves to: (1) Briefly provide evidence and analysis for determining whether to prepare an EIS or a finding of no significant impact (FONSI); (2) aid an agency's compliance with NEPA when no EIS is necessary; (3) facilitate preparation of an EIS when one is necessary. An EA shall include brief discussions of the need for the proposal alternatives [including the "no action" alternative - 10 CFR 1021.231(c)], the environmental consequences of the proposed action and the alternatives, and a listing of agencies and persons consulted [40 CFR 1508.9(3)(b)]. The regulation (10 CFR 1021) also identifies level of NEPA review (EIS, EA, or CX) for typical classes of actions; Appendix C to Subpart D lists actions usually requiring an EA. Some examples of actions that normally require an EA, but not an EIS, are: siting/construction /operation of onsite waste storage facilities (not for high-level or spent nuclear fuel); siting/construction/operation of water treatment facilities; and field demonstration projects for wetlands mitigation.

DOE shall notify host state and host tribe of a determination to prepare an EA. DOE may notify other states and tribes that may be affected by the proposed action. DOE will also provide the host state and host tribe the opportunity to review and comment on any EA prior to its approval.

Table 2.1-3 **Environmental Assessment (EA)**
Includes (40 CFR 1508.9(3)(b)): (1) Brief discussion of the need for the proposal; (2) Brief discussion of alternatives (including the "no action" alternative [10 CFR 1021.231(c)]); (3) Environmental consequences of the proposed action and the alternatives; and, (4) Listing of agencies and persons consulted.

- **Finding Of No Significant Impact (FONSI) – Table 2.1-4**

This is a document by a Federal agency briefly presenting the reasons why an action, not otherwise categorically excluded (10 CFR Part 1021, Appendix A and B to Subpart D), will not have a significant effect on the human environment and for which an EIS, therefore, will not be prepared.

Table 2.1-4 **Finding of No Significant Impact (FONSI)**
Includes: (1) Brief discussion of the reasons why an action will not have a significant effect on the human environment and for which an EIS will, therefore, not be prepared; (2) Summary of the EA and shall note any other environmental documents related to it, including a brief description of the proposed action and alternatives considered in the EA, factors considered, and projected impacts [(10 CFR Part 1021.322(b))]. If the EA is included, the finding need not repeat any of the discussion in the EA, but may incorporate by reference (40 CFR Part 1508.13); (3) Summary of any comments received on the proposed FONSI and comments received on the EA and the disposition of these comments; (4) Any commitments to mitigations that are essential to render the impacts of the proposed action not significant beyond those mitigations that are integral elements of the proposed action and reference to the MITIGATION ACTION PLAN; (5) Any "Statement of Findings" required by 10 CFR Part 1022, "Compliance with Floodplains/Wetlands Environmental Review Requirements"; (6) Date of issuance; and, (7) Signature of the DOE approving officer.

- **Categorical Exclusion (CX)– Table 2.1-5**

  Categorical Exclusions are classes of actions that DOE has determined do not individually or cumulatively have a significant effect on the human environment. In order for an action to be categorical excluded, DOE will determine the following:

  - ◊ That the proposal fits within a class of actions listed in Appendix A or B to Subpart D of 10 CFR Part 1021;
  - ◊ That there are no extraordinary circumstances related to the proposal that may effect the significance of the environmental effects of the proposal; and,
  - ◊ That the proposal is not connected to other actions with potentially significant impacts.

Table 2.1-5 **Categorical Exclusion (CX)**
Separate NEPA documentation is not required for Categorical Exclusions. [DOE Order 451.1 5.d(2)].

Appendix A and B divide categorical exclusions into two sets of actions that usually do not require an EA or EIS. Appendix A contains general agency actions such as routine administration, procedural rulemaking, and transfer of property (if the use is unchanged). Appendix B contains specific agency actions such as modification to screened water intake structures; improvements to fish and wildlife habitat; environmental monitoring; and modifications of facility for storing, packaging, or repacking waste (not high-level or spent nuclear fuel.) Appendix B actions are listed under six different groupings:

- ◊ B1 - CXs applicable to facility operations;
- ◊ B2- CXs applicable to health and safety;
- ◊ B3 - CXs applicable to site characterization, monitoring, and general research;
- ◊ B4 - CXs applicable to Power Marketing Administrations and to all of DOE with regard to power resources;
- ◊ B5 - CXs applicable to conservation, fossil, and renewable energy activities; or,
- ◊ B6 - CX applicable to environmental restoration and waste management activities.

- **Record of Decision (ROD) – Table 2.1-6**

No decision may be made on a proposal covered by an EIS during a 30 day "waiting period" following the completion of the final EIS. The waiting period begins with the publication of the notice of availability for the final EIS in the *Federal Register*. No action shall be taken until the decision has been made public.

The ROD will support the selection of an action and will include all facts, analyses of facts, and site-specific policy determinations considered in the course of carrying out activities will be documented, as appropriate, for inclusion into the administrative record. The ROD shall be published in the *Federal Register*.

Table 2.1-6 Record of Decision (ROD)
Includes: (1) Statement of the decision; (2) Identification of all alternatives considered by the agency in reaching its decision; (3) Specification of the alternative or alternatives which were considered to be environmentally preferable; (4) Discussion of all such factors including any essential considerations of national policy which were balanced by the agency in making its decision and state how those considerations entered into its decision; and, (5) Discussion of whether all practicable means to avoid or minimize environmental harm from the alternative selected have been adopted, and if not, why not. A monitoring and enforcement program shall be adopted and summarized where applicable for any mitigation (40 CFR Part 1505.2).

- **Mitigation Action Plan – Table 2.1-7**

Upon completion of each EIS and associated ROD, DOE will prepare a Mitigation Action Plan. The Mitigation Action Plan will address mitigation commitments in the ROD and explain how the corresponding mitigation measures, designed to mitigate adverse environmental impacts associated with the course of action directed by the ROD, will be planned and implemented. The Mitigation Action Plan shall be prepared before DOE takes any action directed by the ROD.

DOE shall also prepare a MITIGATION ACTION PLAN for commitments to mitigation actions that are essential to render the impacts of the proposed action not significant in an EA. The MITIGATION ACTION PLAN shall address all commitments necessary for mitigation actions and shall explain how mitigation will be planned and implemented. The MITIGATION ACTION PLAN shall be prepared before the FONSI is issued and include information about the course of action to be covered by the FONSI. The MITIGATION ACTION PLAN will be made available for public inspection.

Table 2.1-7 Mitigation Action Plan
Includes 10 CFR 1021.331: (1) Mitigation commitments; and, (2) Description of how mitigation measures will be planned and implemented.

Additional guidance documents and references for EISs and EAs are listed in Table 2.1-8.

Table 2.1-8 **Guidance Documents and References**
CEQ Memorandum to Agencies, March 23, 1981, *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*
Council on Environmental Quality (CEQ) Regulations, 40 CFR Parts 1500-1508, as amended 07/01/86.
DOE Order 451.1, National Environmental Policy Act Compliance Program of 6/16/95.
National Environmental Policy Act, 42 U.S.C. 4321 *et seq.*, of 01/1/70.
U.S. Department of Energy, July 1994, *Questions and Answers on the Secretarial Policy Statement on the National Environmental Policy Act*
Council on Environmental Quality (CEQ) Regulations, 40 CFR Parts 1500-1508, as amended 07/01/86.
U.S. Department of Energy, National Environmental Policy Act, Implementing Procedures and Guidelines, 10 CFR 1021, of 4/24/92.
U.S. Department of Energy, Office of NEPA Oversight, May 1992, *Frequently Asked Questions on the Department of Energy's National Environmental Policy Act Regulations.*
U.S. Department of Energy, Office of NEPA Oversight, May 1993, *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements (Green Book).*
U.S. Department of Energy, Office of NEPA Oversight, August 16, 1994, *Environmental Assessments Checklist.*

b. Discuss the requirements for each document and describe the process of reviewing the above listed documents.

Table 2.1-9 presents the requirements for NEPA documents.

Table 2.1-9
NEPA Document Requirements

Document	Requirements
Implementation Plan (IP) 10 CFR Part 1021.312	• Prepare the IP to provide guidance for the preparation of the EIS and to record the results of the scoping process. • The IP will be completed as soon as possible after the close of the public scoping process • The IP and any formal revisions will be made available to the public.
Environmental Impact Statement 40 CFR Part 1502	• Draft EIS shall list all Federal permits, licenses, and other entitlements which must be obtained in implementing the proposal. • Agencies shall insure the professional integrity, including scientific integrity, of the discussions and analyses in the EISs. • Comments will be obtained from any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved or which is authorized to develop and enforce environmental standards. Comments will be requested from appropriate State and local agencies, tribes, and any agency that has requested that it receive statements on actions of the kind proposed. Responses wil be prepared to all comments. • Impacts shall be discussed in proportion to their significance. There shall be only brief discussion of other than significant issues. • The EIS shall be kept concise. • The EIS shall state how alternatives considered in it and decisions based on it will will not achieve the requirements of Sections 101 and 102(1) of the Act and other environmental laws and policies. • The range of alternatives discussed shall encompass those to be considered by the ultimate agency decision-maker. • Agencies shall not commit resources prejudicing selection of alternatives before making a final decision. • EIS shall serve as the means of assessing the environmental impact of proposed agency actions, rather than justifying decisions already made. • EIS shall be prepared using an interdisciplinary approach. • EIS shall be written in plain language. • Final EIS shall respond to comments. • Agencies shall incorporate material into an EIS by reference to cut down on bulk. • When an agency is evaluating reasonably foreseeable significant adverse effects on the human environment in an EIS and there is incomplete or unavailable informatio the agency shall always make clear that such information is lacking. • If cost-benefit analysis, relevant to the choice among environmental different alternatives, is being considered for the proposed action, it shall be incorporated by reference.

Table 2.1-9
NEPA Document Requirements

Document	Requirements
Environmental Assessment (EA) 40 CFR Parts 1501.3, 1501.4, and 1508.9 10 CFR Part 1021.321	• DOE shall prepare an EA for a proposed DOE action that is described in the classes of actions listed in Appendix C (10 CFR Part 1021) to Subpart D and for a proposed DOE action that is not described in any of the classes of actions listed in Appendices A, B, or D to Subpart D. An EA is not required if DOE has decided to prepare an EIS. • DOE may prepare an EA on any action at any time in order to assist agency planning and decision-making. • A DOE EA shall serve the purpose identified in 40 CFR Part 1508.9(a) which includes providing sufficient evidence and analysis for determining whether to prepare an EIS or to issue a FONSI. • If appropriate, a DOE EA shall also include any floodplains/wetlands assessment prepared under 10 CFR Part 1022.
Finding of No Significant Impacts (FONSI) 10 CFR Part 1021.322	• DOE shall prepare a FONSI only if the related EA supports the finding that the proposed action will not have a significant effect on the human environment. • If a required DOE EA does not support a FONSI, DOE shall prepare an EIS and issue a ROD before taking action on the proposal addressed by the EA. • DOE shall make FONSIs available to the public and issue a proposed FONSI for public review and comment before making a final determination on the FONSI if required by 40 CFR Part 1501.4. • DOE may revise a FONSI at any time, so long as the revision is supported by an existing EA. • Upon issuance of the FONSI, DOE may proceed with the proposed action subject t any mitigation commitments expressed in the FONSI.
Categorical Exclusion (CX)	• The proposal fits within a class of actions listed in Appendix A or B to Subpart D c 10 CFR Part 1021; • There are no extraordinary circumstances related to the proposal that may alter the significance of the environmental effects of the proposal; and • The proposal is not connected to other actions with potentially significant impacts. • Separate NEPA documentation of a CX is not required.
Record of Decision (ROD) 40 CFR Part 1505.2	• If DOE decides to take action on a proposal covered by an EIS, a ROD shall be prepared as provided in 40 CFR Part 1505.2. • No action shall be taken until the decision has been made public. • DOE RODs shall be published in the *Federal Register* and made available to the public. • DOE may revise a ROD at any time, so long as the revised decision is adequately supported by an existing EIS (10 CFR Part 1021.315).
Mitigation Action Plan (MITIGATION ACTION PLAN) 10 CFR Part 1021.331	• Each MITIGATION ACTION PLAN shall be as complete as possible, commensurate with the information available regarding the course of action either directed by the ROD or the action covered by the FONSI, as appropriate. • DOE may revise the MITIGATION ACTION PLAN as more specific and detailed information becomes available. • DOE shall make copies of the MITIGATION ACTION PLAN available for inspection in the appropriate reading rooms and be available upon written request.

Document Review

All NEPA documents should be reviewed for:

- Technical adequacy and accuracy (interdisciplinary review);
- Regulatory adequacy; and,
- Concise and plain language (public documents).

NEPA documents should also be reviewed for NEPA principles. The three essential NEPA principles are:

(1) NEPA documents must be specific. The requirements of NEPA have been legally and sufficiently met only when the agency has enough site-specific information and analyses to make irreversible and irretrievable commitments of resources for a project.

(2) The objective of the proposal, the decisions to be made, and the effects to be considered in the environmental analyses and document must be clearly identified (scope). The scope of the analysis selected by the agency must be appropriate to understand the impacts fully.

(3) The environmental analysis and document must be issue-driven and analytic rather than encyclopedic. Based on the scope and the degree of site-specificity of the particular analysis, the agency identifies adverse environmental impacts that might occur should the proposal or the project objectives be met. The predicted impacts of the proposal and alternatives on each identified issue are evaluated and disclosed in the environmental document.

NEPA documents should be reviewed by an interdisciplinary team for technical adequacy and accuracy. The following documents and resources will assist the reviewer in determining regulatory adequacy:

- Implementation Plan – The reviewer should refer to DOE regulations (10 CFR Part 1021.312) when reviewing an EIS IP.
- Environmental Impact Statement (EIS) or Environmental Assessment (EA) – Two useful documents regarding the review of an EIS or an EA are *Recommendations for the Preparation of Environmental Assessments and Environmental Impact Statements* (Green Book) and U.S. Department of Energy, Office of NEPA Oversight, August 16, 1994, *Environmental Assessments Checklist.*

The reviewer should also be familiar with the following references: the CEQ regulations; the DOE Orders; the Secretarial Policy; CEQ Memorandum to Agencies, March 23, 1981, *Forty Most Asked Questions Concerning CEQ's National Environmental Policy Act Regulations*; U.S. Department of Energy, Office of NEPA Oversight, May 1992, *Frequently Asked Questions on the Department of Energy's National Environmental*

Policy Act Regulations; and U.S. Department of Energy, July 1994, *Questions and Answers on the Secretarial Policy Statement on the National Environmental Policy Act.*

- Finding Of No Significant Impact (FONSI) – The reviewer should refer to CEQ regulations (40 CFR Part 1508.13) and DOE Orders, (10 CFR Part 1021.322) when reviewing a FONSI.
- Categorical Exclusion (CX) – Actions listed in Appendices A and B to Subpart D of 10 CFR Part 1021 are classes of actions that DOE has determined do not individually or cumulatively have a significant effect on the human environment.

A proposal is categorically excluded if it is determined that:

(1) Proposal fits within class of actions listed in Appendix A or B to Subpart D;
(2) There are not extraordinary circumstances related to the proposal that may affect the significance of the environmental effects of the proposal. Extraordinary circumstances are unique situations presented by specific controversy about the environmental effects of the proposal, uncertain effects or effects involving unique or unknown risks, or unresolved conflicts concerning alternate uses of available resources; and,
(3) Proposal is not connected to other actions with potentially significant impacts.

◊ Record of Decision (ROD) – The reviewer should refer to CEQ regulations (40 CFR Part 1505.2) and DOE Orders, (10 CFR Part 1021.315) when reviewing a ROD.

◊ Mitigation Action Plan (MITIGATION ACTION PLAN) – The reviewer should refer to CEQ regulations (40 CFR Part 1508.20) and DOE Orders, (10 CFR Part 1021.3231) when reviewing a MITIGATION ACTION PLAN.

c. Describe the process for performing an assessment of the above-listed documents and discuss criteria that could be used during an assessment.

For individual document review, format criteria, and resource documents, refer to Sections 2.1(a) and (b).

NEPA requires an interdisciplinary approach to document preparation, including the review of documents. DOE Order 451.1 establishes DOE responsibilities for the review of NEPA documents and are listed below. The Secretarial Policy states that, to eliminate multiple cycles of revisions, internal reviews of draft EAs and EISs will be concurrent, rather than sequential.

Secretarial Officer

- Determines if an EA or EIS is the appropriate level of NEPA review;
- Determines once an EA is complete, whether to issue a FONSI or write an EIS;
- Determines if the proposed action is an interim action; and,
- Obtains concurrence of DOE counsel in the legal adequacy of an EA prior to approval.

Head of Field Organization, where authority is delegated

- Determines if an EA or EIS is the appropriate level of NEPA review;
- Determines once an EA is complete, whether to issue a FONSI or write an EIS;
- Determines if the proposed action is an interim action; and,
- Obtains concurrence of DOE counsel in the legal adequacy of an EA prior to approval.

NEPA Compliance Officer

- Makes; CX determinations; and,
- Advises on the adequacy of NEPA documents.

NEPA Document Manager

- Manages the NEPA document preparation process include reviewing internal drafts for technical adequacy.

Assistant Secretary for Environment, Safety and Health

- Evaluates proposed and alternative actions, including alternative mitigation measures; and,
- Approves EIS after the Assistant General Counsel concurs.

Director of NEPA Policy and Assistance

- Provides independent review of proposed actions.

d. Perform a review/assessment of each of the above listed documents.

This is a demonstration skill and an individual will actually be performing the activity rather than acknowledging comprehension. Refer to Sections 2.1(a) and (b) when performing this skill.

e. ***Describe the Department's integration policy for the Comprehensive Environmental Response, Compensation, and Liability Act/National Environmental Policy Act, and method for incorporating National Environmental Policy Act values into environmental restoration documentation.***

To facilitate meeting the environmental objectives of the Comprehensive Environmental Response, Compensation, and Liability Act/National Environmental Policy Act (CERCLA) and respond to concerns of regulators, consistent with the procedures of most other Federal agencies, DOE will rely on the CERCLA process for review of actions to be taken under CERCLA and will address NEPA values and public involvement procedures as provided below:

(1) NEPA reviews will be undertaken for siting, construction, and operation of treatment, storage and disposal facilities that, in addition to supporting CERCLA actions, also serve waste management or other purposes;
(2) DOE CERCLA documents will incorporate NEPA values, such as analysis of cumulative, off-site, ecological, and socioeconomic impacts, to the extent practicable;
(3) DOE will take steps to ensure opportunities for early public involvement in the CERCLA process and will make CERCLA documents available to the public as early as possible; and,
(4) For proposed corrective actions under the Resource Conservation and Recovery Act (RCRA) at sites that are listed on the National Priorities List under CERCLA, project managers should consult with the Environmental Management NEPA Compliance Officer, who will involve the Offices of Environment, Safety and Health and General Counsel as necessary to make determinations about how to proceed under NEPA.

f. ***Discuss the relationship between 40 CFR 1500, Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, and DOE Order 451.1 , National Environmental Policy Act Compliance Program (DOE Order 5440.1E, National Environmental Policy Act Compliance Program, has been canceled).***

The CEQ regulations (40 CFR 1500-1508) implement Section 102 of NEPA and provide Federal agencies with procedures for complying with the intent of NEPA. The DOE regulations (10 CFR 1021) establish the procedures that DOE shall use to comply with Section 102 of NEPA and the CEQ regulations. DOE Order 451.1 establishes the internal requirements and responsibilities for implementing NEPA, the CEQ regulations (40 CFR 1500-1508), and the DOE Implementing Procedures (10 CFR 1021)(Figure 2.1-1).

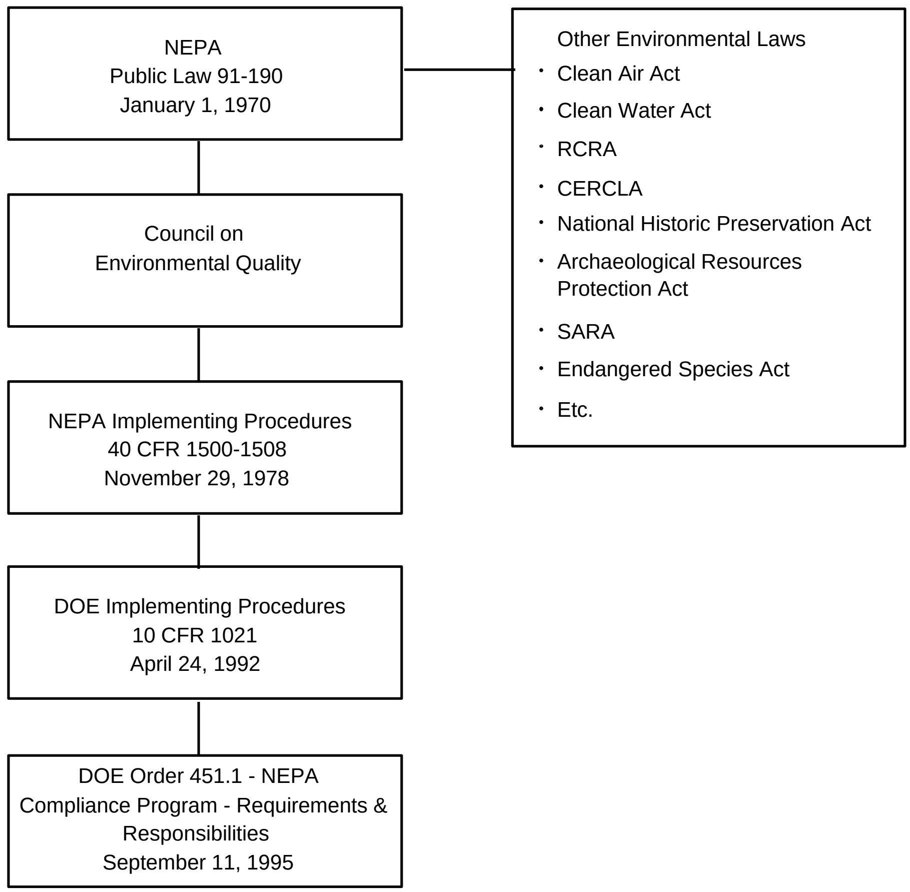

Figure 2.1-1 Implementing Procedures

2.2 Environmental restoration personnel shall demonstrate a working level knowledge of the purpose and process required by the Comprehensive Environmental Response, Compensation, and Liability Act as outlined in the National Contingency Plan.

Supporting Knowledge and/or Skills

a. Discuss the criteria set forth in the National Oil and Hazardous Substances Pollution Contingency Plan for the performance of Cleanup Alternative Analysis.

The purpose of the NCP (40 CFR Part 300) is to provide the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants. Under the procedures detailed in the NCP for remediation alternative analysis there are listed the Nine Evaluation Criteria. The following are the Nine Evaluation Criteria and a short explanation of what they entail:

- **Overall protection of human health and the environment** – Evaluates if the alternative is adequate to protect human health and the environment in terms of short- and long-term risks from hazardous substances;
- **Compliance with Applicable and Relevant and Appropriate Requirements (ARARs) –** Will the alternative attain applicable or relevant and appropriate requirements (ARARs) under Federal and state laws;
- **Long-term effectiveness and permanence** – Examines the long-term effectiveness and permanence of the alternative resulting in a successful remediation;
- **Reduction of toxicity, mobility, or volume through treatment** – Degree to which the alternative employs recycling or treatment that reduces toxicity, mobility, or volume, including what treatment is used to address the main threats from the site;
- **Short-term effectiveness** – Assessment of the short-term risk to the local community during implementation of the alternative, potential impacts to workers, potential impacts to the environment from the alternative, and the time until protection is achieved;
- **Implementability** – The ease or difficulty of implementing the alternative based on technical feasibility, administrative feasibility, and availability of services and materials;
- **Cost –** Examination of capital costs, annual operation and maintenance, and net present value of capital and operation and maintenance;
- **State acceptance** – Assessment of state concerns relating to the preferred alternative and comments on ARARs or proposed use of waivers; and,
- **Community acceptance** – Assessment of the concerns of the community about the alternative. This evaluation is completed after receipt of public comments.

The Nine Evaluation Criteria are applied to each alternative for final selection. The nine evaluation criteria are grouped into three categories. First, are the Threshold Criteria consisting of overall protection of human health and the environment and compliance with ARARs. Each alternative must meet the Threshold Criteria. Second, are the Primary Balancing Criteria consisting of long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Last, are the Modifying Criteria which include state and community acceptance.

b. Describe the requirements for public comment as they apply to the Comprehensive Environmental Response, Compensation, and Liability Act activities.

As stated in Part 300.155 of the NCP, community relations must provide active communication with affected communities. In most cases, EPA will require development of a Community Relations Plan to ensure active participation with the affected community.

For removal, remedial, or enforcement actions, the NCP requires community relations efforts. Each type of action requires a slightly different public involvement process. For example, for a removal action where, based on the site evaluation, the lead agency determines that a removal is appropriate, and less than six months exists before on-site removal activity is to begin, the lead agency shall: (1) publish a notice of availability of the administrative record (AR) in a major local paper of general circulation within 60 days of initiation of on-site removal activity, (2) provide a public comment period of not less than 30 days from the time the AR file is made available for public inspection, and (3) prepare a written response to significant comments.

c. Discuss the purpose and history of the Comprehensive Environmental Response, Compensation, and Liability Act.

The following is taken from the *Environmental Law Handbook*[1]:

The Comprehensive Environmental Response, Comprehensive and Liability Act (CERCLA), or Superfund, was enacted by Congress in 1980. CERCLA was enacted as a response to such environmental disasters as Love Canal where historical waste disposal operations threatened and eventually condemned a residential neighborhood. The nation was realizing that inactive hazardous waste sites presented great risk to public health and the environment and that existing law did not address these abandoned disposal sites. CERCLA was designed to respond to situations involving the past disposal of hazardous substances.

When originally enacted, CERCLA was far less complex than it is today. In 1986, CERCLA was extensively amended by the Superfund Amendments and Reauthorization Act (SARA). SARA added many provisions to CERCLA and clarified much of what was unclear in the original act. However, even after SARA, CERCLA's major emphasis has remained the cleanup of inactive hazardous waste sites and the distribution of cleanup costs among the parties who generated and handled hazardous substances at these sites.

CERCLA's major provisions are designed to address comprehensively the problems associated with hazardous waste sites. CERCLA provides EPA the authority to clean up these sites under what may be generically called its "response" or "remedial" provisions. In doing so, it details the procedures and standards which must be followed in remediating these sites. CERCLA, like most environmental statutes, also contains enforcement provisions. These provisions identify the classes of parties liable under CERCLA, detail the legal claims which arise under the statute, and provide guidance on settlements with EPA. In addition, CERCLA contains provisions specifying when releases of hazardous substances must be reported and the procedures to be followed for the cleanup of Federal installations.

One of the most important features of CERCLA is the creation of the Hazardous Substance Superfund to be used by EPA in cleaning up hazardous waste sites. It is to this fund that CERCLA owes its "Superfund" nickname. The Superfund is created by taxes imposed upon the petroleum and chemical industries as well as by an environmental tax on corporations. In addition, general tax revenue is contributed to the Superfund. The SARA Amendments authorized an appropriation of $8.5 million for the five-year period beginning in 1986. In 1990, Congress reauthorized the Superfund program until September 14, 1994 at a funding level of $5.1 billion. Currently, the Superfund is being evaluated by Congress for another Reauthorization.

The Superfund may be used, not only to pay EPA's cleanup and enforcement costs and certain natural resource damages, but also to pay for certain claims of private parties. Private parties are entitled to payment from the Superfund for EPA-approved cleanups that they have performed. In addition, private parties may file claims for reimbursement when they have performed a cleanup but have been unable to obtain payment from the facility owner or operator, or when EPA has administratively required them to conduct a cleanup that is deemed to be arbitrary and capricious or for which they are not liable. However, the Superfund may not be used to finance the remediation of Federal facilities.

The primary guidance document for CERCLA response actions is the National Contingency Plan (NCP). The NCP sets forth the procedures which must be followed by EPA and private parties in selecting and conducting CERCLA response actions. The NCP provides the organizational structure and procedures for preparing for and responding to discharges of oil and releases of hazardous substances, pollutants, and contaminants.

The NCP is required by Section 105 of CERCLA, 42 U.S.C. 9605, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), Pub. L. 99-499, (hereinafter CERCLA), and by Section 311(c)(2) of the Clean Water Act (CWA), as amended, 33 U.S.C. 1321(c)(2). In Executive Order (E.O.) 12580 (52 FR 2923, January 29, 1987), the President delegated to the EPA the responsibility for the amendment of the NCP. Amendments to the NCP are coordinated with members of the National Response Team (NRT) prior to publication for notice and comment. This includes coordination with the Federal Emergency Management Agency and the Nuclear Regulatory Commission in order to avoid inconsistent or duplicative requirements in the emergency planning responsibilities of those agencies. The NCP is applicable to response actions taken pursuant to the authorities under CERCLA and Section 311 of the CWA.

d. ***Discuss the relationship between the Comprehensive Environmental Response, Compensation, and Liability Act and all other environmental regulations, especially the relationship between the Comprehensive Environmental Response, Compensation, and Liability Act and the Resource Conservation and Recovery Act.***

Generally, CERCLA was enacted in 1980 to protect the human health and the environment from risks associated with inactive or abandoned hazardous waste sites. CERCLA was designed to respond to situations involving the past disposal of hazardous substances. CERCLA requires an assessment and compliance with all pertinent environmental laws as discussed in Section 2.3 (Applicable and Relevant and Appropriate Requirements). CERCLA is complemented by the Resource Conservation and Recovery Act (RCRA) which regulates and permits on-going hazardous waste handling and disposal. RCRA was enacted in 1976 to provide "cradle-to-grave" control of hazardous waste by imposing management requirements on generators and transporters of hazardous wastes and upon owners and operators of treatment, storage, and disposal (TSD) facilities. Figure 2.2-1 depicts the “cradle to grave” system, the management of hazardous wastes from their generation to final treatment or disposal[1].

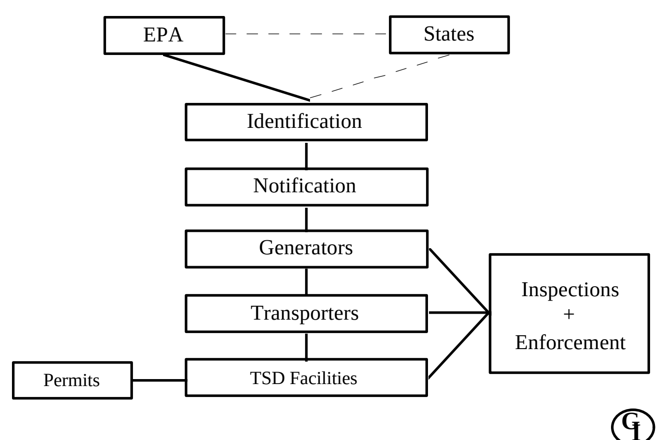

Figure 2.2-1
RCRA "Cradle To Grave" System

Specifically, the relationship between CERCLA and RCRA creates regulatory requirements that at best are redundant and at worst are contradictory; both situations result in increasing costs of environmental compliance. Key issues that arise due to the relationship of CERCLA and RCRA are listed and discussed in further detail below:

- RCRA serves as an important ARAR for CERCLA remedial actions.

  For example, EPA guidance[2] describes how Investigation-Derived Waste (IDW), or Investigative-Derived Material (IDM), is to be managed at National Priority List (NPL) sites under CERCLA. The document discusses compliance with RCRA as an ARAR under CERCLA. An NPL site must meet the substantive requirements of RCRA but is exempt from administrative (i.e., permit) requirements. This is also stated in Section 121 (e) of CERCLA which also provides a state with enforcement authority over CERCLA remedial action. In other words, a state may enforce a CERCLA cleanup through its authority under RCRA. Within the DOE complex this can and has resulted in the state requiring DOE to manage IDW/IDM under the regulations of both CERCLA and RCRA. This dual regulation creates inefficiencies, additional costs, and schedule delays in implementing CERCLA cleanups.

  Another example of the extra burden of complying with CERCLA and RCRA is that DOE ER activities are regulated under an Interagency Agreement (IA) and the RCRA Part B Permit. Instead of complying with RCRA as an ARAR under CERCLA, DOE is required to obtain permit modifications for CERCLA remedial actions. These permit modifications are administrative requirements of RCRA that are not generally required at NPL sites. Again, these administrative requirements use extra time and funds, creating compliance inefficiencies.

- Baseline Risk Assessment Methodologies are different under CERCLA and RCRA.

  The baseline risk assessment methodologies for exposure assessment data aggregation to comply with EPA CERCLA and RCRA requirements are different. In developing a list of chemical of concerns (COCs) for the baseline risk assessment, RCRA methodologies are usually more conservative than CERCLA methods, potentially resulting in unnecessary additional cleanup at CERCLA sites. Moreover, using two methodologies and developing two lists is more costly and requires more time for the baseline risk assessment.

  By developing a more conservative list of COCs, several additional issues then become paramount in the Feasibility Study (FS) phase of a CERCLA remediation, known under RCRA as the Corrective Measures Study (CMS). Usually the COCs addressed under the CERCLA FS are a subset of the larger list of COCs developed under the RCRA CMS. Thus, RCRA requires the analysis of additional COCs not required by CERCLA. Additionally, the spatial scale of remediation is generally different under CERCLA and RCRA. Under CERCLA, remedial action is generally evaluated on an Operable Unit (OU) basis. Under RCRA a corrective action is evaluated on a solid waste management unit basis under Section 3004 (u) of RCRA. These different approaches create inefficiencies in costs and schedules.

Finally, due to the RCRA/CERCLA relationship the remedy selection for remediation of a site becomes more complicated. The reasons for this complication include: (1) differences in COCs developed for the CERCLA Record of Decision (RODs) and RCRA Corrective Action Decisions (CADs); (2) differences in selected remedies due to the differences in spatial scales of remedial actions; (3) differences in cleanup concentration levels, and (4) differences in land use assumptions. Items 1 and 2 have been discussed above. The differences in spatial scale result in a CAD that deals with a limited area such as an Individual Hazardous Substance Site (IHSS), while the ROD will consist of remedial actions most likely at a spatial scale grater than an IHSS. There is great potential for different actions to be taken under CERCLA versus RCRA due to differences in COCs alone. Clean up concentration levels will likely be different under the different regulations. The NCP gives a cumulative carcinogenic site risk range of 1×10^{-6} to 1×10^{-4}, with 1×10^{-6} being the point of departure. However, the EPA guidelines[3] state that, in general, remedial action is not warranted if the risk is less than 1×10^{-4}. Exceptions include adverse environmental impacts, chemical-specific ARARs, and site specific reasons. Future land use assumptions for risk management are likely to be different under CERCLA and RCRA. The preamble to the NCP states that an assumption of future residential land use is not a requirement; whereas, a state may require DOE to clean up to a residential exposure limit.

- The Application of Land Disposal Restrictions (LDRs) to CERCLA Response Actions

Land Disposal Restrictions (LDRs) are regulated under RCRA. However, for LDRs to be applicable to a CERCLA response, the action must constitute placement of a restricted RCRA hazardous waste. Therefore, remediation project managers must answer three questions to determine if LDRs are applicable. First, does the response action constitute placement? Second, is the CERCLA substance being placed also a RCRA hazardous waste? Lastly, is the RCRA waste restricted under the LDRs?

LDRs mandate specific restrictions on RCRA hazardous wastes prior to placement of wastes into a land disposal unit. Land disposal units include landfills, surface impoundments, waste piles, injection wells, land treatment facilities, salt dome formations, underground mines or caves, and concrete bunkers or vaults. If a CERCLA response includes disposal of waste in any of these types of off-site land disposal units, placement will occur. On-site disposal is less clear because many CERCLA sites have widespread and dispersed contamination. Even so, if LDRs are mandated, then the CERCLA site must treat to specified concentration levels prior to placement on-site.

Because a CERCLA response must constitute placement of a restricted RCRA hazardous waste for the LDRs to be applicable, all contaminants at a CERCLA site must be evaluated as to whether or not they are RCRA hazardous wastes. The two types of RCRA hazardous waste are listed and characteristic wastes. In addition to understanding the two categories of RCRA hazardous wastes, an understanding of the derived-from rule [40 CFR 261.3 (c)(2)], the mixture rule [40 CFR 261.3 (a)(2)], and the contained-in interpretation (OSW Memorandum dated 11/13/86) is necessary to identify correctly whether a CERCLA substance is a RCRA hazardous waste. Also, an understanding of the RCRA delisting process (40 CFR 260.20 and .22) is needed.

If a CERCLA waste is determined to be a RCRA hazardous waste, this waste must also be restricted for the LDRs to be an applicable requirement. Therefore, the project manager must determine if the waste is a restricted waste and dispose of it in an appropriate manner.

- <u>CERCLA remedial actions and RCRA corrective actions taking place at the same site</u>.

  Under the Federal Facilities Compliance Act (FFCA) a CERCLA remedial action and a RCRA corrective action may take place at the same site. Most DOE facilities have tried to integrate these two regulations by integrating the two laws in an Interagency Agreement (IA) or some other type of agency cooperative document. Within the IA, all agencies involved, usually DOE, EPA and the state, agree to how the site will be remediated from a regulatory point of view.

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[1] *Environmental Law Handbook*, 12th ed., Arbuckle, et. al., published by Government Institutes, Inc., Rockville, MD, 1993.
[2] *Guide to Management of Investigation-Derived Wastes*, Environmental Protection Agency, Pub. 9345.3, January 1992.
[3] *Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions*, Environmental Protection Agency, OSWER Directive 9355.0-30, 1991.

2.3 Environmental restoration personnel shall demonstrate a working level knowledge of the following document development, review, and assessment under the Comprehensive Environmental Response, Compensation, and Liability Act:

- Remedial Investigation Feasibility Study Work Plan
- Investigative Work Plan Report
- Permits
- Records of Decision
- Remedial Design
- Remedial Action Work Plan
- Consent Order & Settlement Agreement
- Proposed Plan
- Applicable or Relevant and Appropriate Requirements (ARARs) (Note: Change made because terminology and standard incorrect.)

Supporting Knowledge and/or Skills

a. Describe the process for developing the elements of the above listed documents. Include a discussion of the format used and guidance, if any, available for each document.

RI/FS Work Plan – Work plans and attached or referenced supporting project plans document the decisions and evaluations made during the scoping process of the site investigation. The work plan presents the facility setting and the objectives, tasks, and schedule for conducting the CERCLA RI/FS. Work plans also present the background data, if any, data evaluation, and project direction for conducting a field investigation.

General format of a RI/FS work plan includes: (1) Introduction - Implementation of the RI/FS, Project Goals, Organization of the Work Plan, Quality Assurance/Quality Control (QA/QC); (2) Background and Physical Setting; (3) Initial Evaluation; (4) Work Plan Approach and Rationale - Data Quality Objectives (DQOs); (5) RI/FS Tasks - field investigation, sampling and analysis plan, interim actions, treatability studies, risk assessment, ecological evaluation, etc.; (6) Project Schedule; and, (7) Project Management - staffing, coordination.

Guidance documents include: (1) *Guidance for Conducting RI and FS Under CERCLA* (EPA, 1988); (2) *DQO Objectives for Remedial Response Activities* (EPA, 1987); (3) *Interim Guidance and Specifications for Preparing QA Project Plans* (EPA, 1983); (4) *Superfund Exposure Manual* (EPA, 1988); (5) *Risk Assessment Guidance for Superfund*, Volume I, Human Health Evaluation Manual, Part A, Interim Final (EPA, 1989); and, (6) *Risk Assessment Guidance for Superfund*, Volume II, Environmental Evaluation Manual (EPA, 1989).

Investigative Work Plan Report – Generally consists of: (1) Introduction (site location, history, investigation strategy, data validation); (2) Investigations Activities and Results (geology, hydrogeology, downhole geophysics as appropriate, soil and groundwater contamination); (3) Qualitative Risk Assessment (QRA summary of data analysis and uncertainty, human health QRA and uncertainty, ecological risk assessment and uncertainty, qualitative overview of potential groundwater impacts from sources); (4) Contaminants of Concern in the soil and groundwater; and, (5) Conclusions.

Permits – Within the DOE complex, most environmental restoration work is performed under an Interagency Agreement which is signed by the DOE, EPA and state representatives. Such an agreement requires that the cleanup programs integrate the requirements of CERCLA, RCRA, and the state's regulations. EPA maintains authority for CERCLA, while the state usually implements RCRA under the authority of the state's hazardous waste program. As such, permits like a RCRA Part B permit may be required if the site is currently operating as a treatment/storage/disposal (TSD) facility or a National Pollutant Discharge Elimination System (NPDES) permit if the site is discharging waste into waters of the U.S. The state may or may not have received authorization to implement the EPA's radioactive mixed waste program.

No Federal, state, or local permits are required for on-site response actions pursuant to CERCLA Sections 104, 106, 121, or 122.

Record of Decision – The purpose of the remedy selection process is to implement remedies that eliminate, reduce, or control risks to human health and the environment. Remedial actions are to be implemented as soon as site data and information make it possible to do so. To support the selection of a remedial action, all facts, analyses of facts, and site-specific policy determinations considered in the course of carrying out activities in this section shall be documented, as appropriate, in a Record of Decision (ROD) for inclusion in the administrative record. The ROD shall describe the following:

- How the selected remedy is protective of human health and the environment;
- Federal and state requirements that are both applicable, relevant, and appropriate to the site and that the remedy will attain;
- The applicable or relevant and appropriate requirements of other Federal and state laws that the remedy will not meet, the waiver invoked, and the justification for invoking the waiver;
- How the remedy is cost effective;
- Whether the preference for remedies employing treatment which permanently and significantly reduces toxicity, mobility, or volume of the hazardous materials as a principal element is or is not satisfied by the selected remedy. If this preference is not satisfied, the ROD must explain why a remedial action involving such reductions in toxicity, mobility, or volume was not selected;
- Indicate remediation goals;
- Discussion of significant changes and the response to significant comments, criticisms, and new relevant information submitted during the public comment period;

- Description of whether hazardous materials will remain at the site such that a review of the remedial action no less than every five years shall be required; and,
- Provide, as appropriate, commitment for further analysis and selection of long-term response measures within an appropriate time-frame.

Remedial Design – Remedial design/remedial action (RD/RA) includes the development of the actual design of the selected remedy and implementation of the remedy through construction. Treatability Studies evaluate the design of the preferred technology.

Remedial Action Work Plan – Typical format includes: (1) Introduction (Treatability Study Program); (2) Alternative Description and Technology Selection; (3) Treatability Study Performance and Data Quality Objectives; (4) Treatability Study Design and Operating Requirements; (5) Supporting Documents; and, (6) Schedule.

Supporting documents include: Site characterization reports, health and safety plans, project management plan, data management plan, hazardous waste operation permit, radiation work permit, safety analysis plan, standard operation procedure plan.

Consent Order and Settlement Agreement – CERCLA Section 122 "Settlements" gives authority to EPA to enter into agreements with any person, including the owner or operator, to perform any response action if it is deemed that such action will be done properly by the person. Whenever practicable and in the public interest, as determined by the President, the President shall act to facilitate agreements under this section that are in the public interest, and consistent with the NCP in order to expedite effective remedial actions and minimize litigation.

Consent Decree – Whenever the President enters into an agreement with the any Potentially Responsible Party (PRP) with respect to remedial action under CERCLA Section 106, the agreement shall be entered in the appropriate United States district court as a consent decree. The entry of any consent decree shall not be construed to be an acknowledgment by the parties that the release or threatened release constitutes an imminent and substantial endangerment to the public health or welfare or the environment. Except as otherwise provided in the Federal Rules of Evidence, the participation by any party in the process under Section 122 shall not be considered an admission of liability for any purpose, and the fact of participation shall not be admissible in any judicial or administrative proceeding.

The Interagency Agreement signed by DOE, EPA, and the state usually contains the consent decree for the cleanup of a particular site. The Agreement is a legal document that binds DOE to actions complying with RCRA, CERCLA, and state hazardous waste laws. EPA's jurisdiction to enter into this Agreement is given by Section 120(e) - Federal Facilities. Pursuant to Section 3006 of RCRA and 42 U.S.C. Section 6946, EPA can authorize the state to administer and enforce a state hazardous waste management program whose requirements are equivalent to requirements set forth in Subtitle C of

RCRA. The state's environmental agency is then designated to implement and enforce provisions of RCRA and enters into the Agreement pursuant to CERCLA, RCRA, and the state's hazardous waste laws. DOE usually enters into such an agreement pursuant to CERCLA, RCRA, Executive Orders, and the Atomic Energy Act.

Proposed Plan – Proposed plans are developed in accordance with the Interagency Agreement and Consent Order using information detailed in appropriate characterization and engineering documents. The proposed plan describes a remedial action and is issued by the EPA, the state, and DOE to the public consistent with CERCLA Section 117. A reasonable period for written and oral comments regarding the proposed plan is required before the final remedial action plan is issued. The proposed plan is the first step in the remedy selection process.

Applicable or Relevant and Appropriate Requirements (ARARs) – are those cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, or other circumstance found at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than Federal requirements may be applicable.

The basic criteria for applicability is that a requirement must specifically address one of the following factors found at a CERCLA site: a hazardous substance, pollutant, or contaminant; type of remedial action; location; or other site-specific circumstances. Only substantive requirements, as opposed to administrative requirements, can be applicable, and only requirements that are promulgated before the ROD, which selects a final remedy, is signed can be applicable.

Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive requirements, criteria, or limitations promulgated under Federal environmental or state environmental or facility siting laws that, while not 'applicable' to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site. Only those state standards that are identified in a timely manner and are more stringent than Federal requirements may be relevant and appropriate.

b. Discuss the requirements of each document and describe the process for reviewing the above listed documents.

RI/FS Work Plan – The purpose of the RI/FS study is to assess site conditions and evaluate alternatives to the extent necessary to select a remedy. Developing and conducting an RI/FS generally includes: project scoping, data collection, risk assessment, ecological evaluation, treatability studies, and analysis of alternatives. The remediation process begins with the Work Plan and includes an analysis of existing data, a preliminary conceptual model, identification of data needs, and an evaluation of data adequacy. The Work Plan represents a document that describes how and where data will be acquired. Review and comments by the lead regulatory agency shall be provided with adequate specificity so that DOE can make necessary changes to the document. Comments shall refer to any pertinent sources of authority or references upon which the comments are based and, upon request of the DOE, the commenting agency shall provide a copy of the cited authority or reference. The lead regulatory agency may extend the comment period for a specified period by written notice to the DOE prior to the end of the initial comment period. DOE will update the document or respond to the comments. The response will address all written comments and will include a schedule for obtaining additional information as required.

Investigative Work Plan – Same as RI/FS Work Plan above.

Permits – No Federal, state, or local permits are required for on-site response actions pursuant to CERCLA Sections 104, 106, 121, or 122.

Records of Decision – See response under Section 2.3(a.).

Remedial Design – The RD/RA shall be in conformance with the remedy selected and set forth in the ROD or other decision documents for that site. Those portions of RD/RA sampling and analysis plans describing the QA/QC requirements for chemical and analytical testing and sampling procedures of samples taken for the purpose of determining whether cleanup action levels specified in the ROD are achieved, generally will be consistent with 40 CFR Part 300.430(b)(8). Remedial design documents might include: design drawings, specifications of construction materials, construction procedures, and all constraints, construction budget, schedules, and supporting documents.

During the course of the RD/RA, the lead agency shall be responsible for ensuring that all Federal and state requirements that are identified in the ROD as ARARs for the action are met. Comments will be addressed as discussed under RI/FS Work Plan.

Remedial Action Work Plan – See discussion above under Section 2.3(a). Comments will be addressed as discussed under the RI/FS Work Plan.

Consent Order and Settlement Agreement – See discussion above under Section 2.3(a).

Proposed Plan – A proposed plan includes: site background, summary of site risks, need for remedial action, action objectives, detailed description of alternatives, comparative analysis of alternatives based upon EPA's Nine Evaluation Criteria, Summary of Preferred Alternative, and glossary. Comments will be addressed as discussed under the RI/FS Work Plan.

Applicable or Relevant and Appropriate Requirements (ARARs)

See response under Section 2.3(a).

c. Perform a review/assessment of each of the above listed documents.

This is a demonstration skill and an individual will actually be performing the activity rather than acknowledging comprehension. Information for this topic is located in Sections 2.3(a) and (b).

2.4 Environmental restoration personnel shall demonstrate a working level knowledge of the management and negotiation of regulatory agreements and permits.

Supporting Knowledge and/or Skills

a. Describe the responsibilities in management of the following documents:

- Federal Facility Agreement
- Consent Order & Settlement Agreements
- Records of Decision
- Resource Conservation and Recovery Act Part B Permits

Federal Facility

Agreement – The SARA Amendments to CERCLA (1986) enacted an entire section devoted to the cleanup of Federal facilities (Section 120). CERCLA Section 120 requires substantive and procedural cleanup of Federal facilities to the same extent as any private company or firm. CERCLA contains waivers of sovereign immunity for Federal agencies; individuals and states may bring cost recovery actions and citizens may bring suits against Federal facilities. Requirements of CERCLA Section 120 include:

- Requirements associated with listing sites on the National Priority List (NPL) (site assessments, hazardous ranking, evaluation procedures); and

- Creation of a Federal Agency Hazardous Waste Compliance Docket that lists facilities which manage hazardous waste or have potential hazardous waste issues.

Once sites are listed on the Compliance Docket, timetables are prepared for addressing problems. Within 18 months, preliminary assessments and site inspections are required. The facility is then scored under the hazardous ranking system to place it on the NPL. If listed, the facility must begin a Remedial Investigation/Feasibility Study (RI/FS) within six months. During the RI/FS stage, consultation with EPA must occur. Within 180 days of EPA's review of the RI/FS, an interagency agreement (for remedy selection) between EPA and the agency must be signed.

Once signed, management of a Federal facility agreement requires a complete understanding of compliance schedules, performance standards, and reporting requirements.

The Federal Facility Compliance Act of 1992 (FFCA) amended RCRA. The FFCA waived sovereign immunity with respect to the imposition of administrative and civil fines and penalties against Federal agencies. Agencies, therefore, could be fined for violations of Federal, state, and local statutes associated with hazardous waste management (handling, transport, treatment, storage, and disposal of solid and hazardous wastes). The practical effect of this legislation is that Federal agencies, for the purposes of environmental enforcement penalty actions, are in similar positions as private and commercial entities.

The FFCA provides EPA with authority to issue administrative compliance orders. The agency has 30 days from the date of receipt of the compliance order to file a response. Informal settlement conferences and exchanges are attempted to resolve issues. If those fail, cases may proceed to an administrative law judge for resolution.

Consent Order & Settlement Agreements – Settlements with the EPA are usually formalized in a CERCLA consent decree or a consent order (administrative order on consent). A consent decree is filed with and signed by a Federal court. A consent order, on the other hand, does not require judicial action.

Management of consent orders and settlement agreements require a complete understanding of compliance schedules, performance standards, and reporting requirements. Failure to meet commitments may result in payment of stipulated penalties for non-compliance.

Records of Decision – After completion of the RI/FS, the agency issues a Record of Decision (ROD) to summarize the selected remedy as supported by facts, analyses of facts, and site specific policy determinations.

After a public comment review period and public hearings, a final ROD is published. The agency is responsible for implementing all remedial actions identified in the ROD. Managing the requirements of the remediation effort require an understanding of the remediation selection and an implementation plan to complete cleanup requirements.

Resource Conservation and Recovery Act Part B Permits – RCRA requires owners and operators of Treatment, Storage, and Disposal (TSD) units to get a permit per RCRA Section 3005. A Permit A application contains basic facility information. A Permit B application is a detailed document that provides information demonstrating compliance with applicable technical standards for TSD facilities, including written plans and procedures related to facility operations. Technical standards for a facility will be governed by the final RCRA permit. States with delegation authority from EPA administer programs to review applications and issue permits. Permits are issued when the facility has been found to comply with all relevant RCRA requirements.

Under RCRA, EPA can take several types of enforcement action; administrative orders and civil and criminal penalties can be imposed on TSD facilities. Violators may be issued a compliance order or EPA may seek injunctive relief in a U.S. District Court. Failure to comply with an administrative order may result in either suspension or revocation of a facility's RCRA permit. Civil penalties may be levied for up to $25,000 for per day per violation. In addition, criminal penalties may be imposed for up to $50,000, two years in prison, or both for knowingly committing certain violations. Violations for knowing endangerment may result in fines of up to $250,000 and up to fifteen years imprisonment.

Government officials responsible for management of RCRA Part B Permits; therefore, should clearly consider the message sent by Congress that more rigorous enforcement of hazardous waste laws is intended. Responsible officials should be familiar with all RCRA Part B Permit requirements and assure internal controls are sufficient to ensure compliance.

b. Discuss the requirements and methods of negotiation for the following documents:

- Federal Facility Agreement
- Consent Order & Settlement Agreements
- Records of Decision
- Resource Conservation and Recovery Act Part B permit parameters
- Grant conditions

Federal Facility Agreement:

<u>CERCLA</u> – Under CERCLA 120, negotiation opportunities exist when, after completion of the RI/FS, consultation with the EPA is initiated. The RI/FS provides the agency's strategy for remediating the site. EPA's agreement with the selection of the proposed remediation plan is essential. Once agreement is achieved, the two Federal agencies can enter into an interagency agreement.

<u>RCRA</u> – The FFCA provides EPA with authority to issue administrative compliance orders. The agency has 30 days from the date of receipt of the compliance order to file a response. Informal settlement conferences and exchanges are attempted to resolve issues. If those fail, cases may proceed to an administrative law judge for resolution. An opportunity for negotiation and agreement exists during informal settlement conferences and exchanges. If those fail, an administrative law judge will determine the settlement.

Further, negotiation opportunities exist in determining appropriate facility penalties. Generally, penalty amounts have been decreased considerably through exchanges and negotiations. In some situations, supplemental environmental projects have been substituted for payment of penalties and fines.

Consent Order & Settlement Agreements – Settlements with EPA are negotiated, then formalized into consent decrees or orders. Terms and conditions of CERCLA consent decrees and orders have historically been heavily negotiated between EPA and potential settlers. Recent trends have resulted in the drafting of model consent decrees and orders, which are much less subject to negotiation. Potential settlers, however, should continue to negotiate in good faith regarding terms and conditions that are considered appropriate for their site and/or facility.

While many CERCLA cases have gone to court, the majority have been resolved through settlement procedures. Settlement of the preferred option for EPA saves financial and staff resources. In addition, settlement agreements offer Potentially Responsible Parties (PRPs) more control over remediation selection. Some control, in addition to the elimination of a need to litigate, may help control costs. While negotiations may be difficult, and possibly protracted and costly (especially given multi-party sites), negotiations often result in settlement agreements.

In the past, EPA's strong stance toward remediation actions and settlement terms and conditions, have resulted in some PRPs performing cleanups under routinely issued EPA Section 106 administrative orders. In addition, restrictive CERCLA provisions, the publication and implementation of EPA guidance, and use of model settlement agreements have resulted in less EPA flexibility.

Nonetheless, CERCLA settlements are subject to a great amount of negotiation. The following issues commonly arise in CERCLA settlements, and are subject to negotiations. Because of the frequency of occurrence of these issues in CERCLA settlements, Section 122 and individual EPA guidance discuss them in greater detail.

- "Mixed funding" determinations (partial funding by the Superfund), especially if the sites are found to be multi-party (has multiple PRPs) may be negotiated. EPA, for example, has authority to provide funds for CERCLA sites, especially to fund "orphan shares" for cleanup responsibilities of companies that have gone bankrupt or are defunct. In addition, EPA has authority to "carve out" a portion of its costs or remediation costs to be funded by nonsettling PRPs.

- Incorporation of "not to sue" covenants in agreements, to assure that EPA will not sue in the future, may be a negotiation point. Given that negotiation of a settlement with EPA does not assure a complete release from future liability, such covenants provide a commitment by EPA not to sue, except in certain designated circumstances. In addition, covenants to not sue must be accompanied by reopeners (a provision which allows EPA to sue for future liability for unknown conditions).

- Settlements for *de minimis* level of responsibility may be agreed upon by EPA and PRPs. At many multi-party sites, a large number of companies may have disposed of small quantities of hazardous substances. In return for a premium payment, *de minimis* parties may receive a settlement of real finality, which assures no future requirement to participate in future remediation activities.

- Agreement on stipulated penalties in the event that milestones were not met may be incorporated into settlement language. The use and amount of such penalties are subject to negotiation. EPA ties penalties to compliance schedules, performance standards, and reporting requirements.

Records Of Decision – Under CERCLA 120, negotiation opportunities exist when, after completion of the RI/FS, consultation with the EPA is initiated. The RI/FS provides the agency's strategy for remediating the site. EPA's agreement with the selection of the proposed remediation plan is essential. Once agreement is achieved, the two Federal agencies can enter into an interagency agreement.

After completion of the RI/FS, the agency issues a Record of Decision (ROD) to summarize the selected remedy as supported by facts, analyses of facts, and site specific policy determinations. The EPA and other stakeholders have the opportunity to review and comment on the ROD. Comments are reviewed by the agency and either incorporated or not incorporated (with justification). A Responsiveness Summary is prepared by the agency summarizing the disposition of all comments. Differences between the agency and the EPA may be negotiated prior to final publication of the ROD.

Resource Conservation and Recovery Act Part B permit parameters – RCRA Part B Permit requirements are subject to negotiation and agreement. Such requirements should be negotiated in good faith with the regulators. A Permit B application is a detailed document that provides information demonstrating compliance with applicable technical standards for TSD facilities, including written plans and procedures related to facility operations. Since technical standards for a facility will be governed by the final RCRA permit, negotiation opportunities exist in defining appropriate technical standards for the facility.

Grant conditions – Under certain circumstances the building of a component/portion of a wastewater treatment system may be justified in advance of completing all NEPA requirements for the remainder of the system(s). When there are overriding considerations of cost or impaired program effectiveness, the responsible official may award a construction grant, or approve procurement by other than EPA funds, for a discrete component of a complete wastewater treatment system(s). The process of partitioning the environmental review for the discrete component shall comply with the criteria and procedures described below in the “Criteria for partitioning”In addition, all reasonable alternatives for the overall wastewater treatment works system(s) of which the component is a part shall have been previously identified.

Criteria for partitioning:

- Projects may be partitioned under the following circumstances:

  ◊ To overcome impaired program effectiveness, the project component, must immediately remedy a severe public health, water quality or other environmental problem; or

  ◊ To significantly reduce direct costs on EPA projects, or other related public works projects, the project component (such as major pieces of equipment, portions of conveyances or small structures) must achieve a cost savings to the

Federal government and/or to the grantee's or potential grantee's overall costs incurred in procuring the wastewater treatment component(s) and/or the installation of other related public works projects funded in coordination with other Federal, state, tribal or local agencies.

- The project component also must:

  ◊ Not foreclose any reasonable alternatives identified for the overall wastewater treatment works system(s);

  ◊ Not cause significant adverse direct or indirect environmental impacts including those which cannot be acceptably mitigated without completing the entire wastewater treatment system of which the component is a part; and

  ◊ Not be highly controversial.

Requests for partitioning: The applicant's or state's request for partitioning must contain the following:

- A description of the discrete component proposed for construction before completing the environmental review of the entire facilities plan;
- How the component meets the above criteria;
- The environmental information required by this subpart for the component; and
- Any preliminary information that may be important to EPA in an EIS determination for the entire facilities plan.

Approval of requests for partitioning: The responsible official shall:

- Review the request for partitioning against all requirements of this subpart;
- If approvable, prepare and issue a Finding of No Significant Impact (FONSI); and,
- Include a grant condition prohibiting the building of additional or different components of the entire facilities system(s) in the planning area.

(50 FR 26317, June 25, 1985, as amended at 51 FR 32612, Sept. 12, 1986)

Facilities plan approval: Before awarding grant assistance for any project the Regional Administrator shall approve the facilities plan and final design drawings and specifications and determine that the applicant and the applicant's project have met all the applicable requirements.

Agreement on eligible costs:

- The Regional Administrator and the grant applicant will enter into a written agreement which will specify the items in the proposed project that are eligible for Federal payments and which shall be incorporated as a special grant condition in the grant award.

- Notwithstanding such agreement, the Regional Administrator may:

  ◊ Modify eligibility determinations that are found to violate applicable Federal statutes and regulations;

  ◊ Conduct an audit of the project;

  ◊ Withhold or recover Federal funds for costs that are found to be unreasonable, unsupported by adequate documentation or otherwise unallowable under applicable Federal cost principles; and/or,

  ◊ Withhold or recover Federal funds for costs that are incurred on a project that fails to meet the design specifications or effluent limitations contained in the grant agreement and NPDES permit issued under section 402 of the Act.

(55 FR 27096, June 29, 1990)

2.5 Environmental restoration personnel shall demonstrate a working level knowledge of the Resource Conservation and Recovery Act Corrective Action Process.

Supporting Knowledge and/or Skills

a. Describe the purpose and the history of the Resource Conservation and Recovery Act.

The Resource Conservation and Recovery Act (RCRA) of 1976 mandated a cradle-to-grave system, the management of hazardous wastes from their generation to final treatment or disposal (Figure 2.5-1)[1]. Regulations adopted by the Environmental Protection Agency (EPA) carry out that mandate and the chain of regulation now extends to those who generate, transport, store, treat, and dispose of hazardous waste. Subtitle C of RCRA forms the basis of EPA's involvement with hazardous waste. The Solid Waste Disposal Act Amendments of 1980, signed into law by President Carter, made several important changes in, and additions to, Subtitle C. Basically, these amendments gave teeth to the enforcement side of RCRA, adding significant criminal and civil penalties for RCRA violations. In 1984, President Reagan signed into law the Hazardous and Solid Waste Amendments of 1984 (HSWA). HSWA broadened the government restrictions on land disposal of hazardous waste and greatly increased the number of waste generators subject to EPA regulation. Other provisions of the new bill were aimed at significantly improving the quality of landfills and surface impoundments and placed underground storage tanks under RCRA regulation.

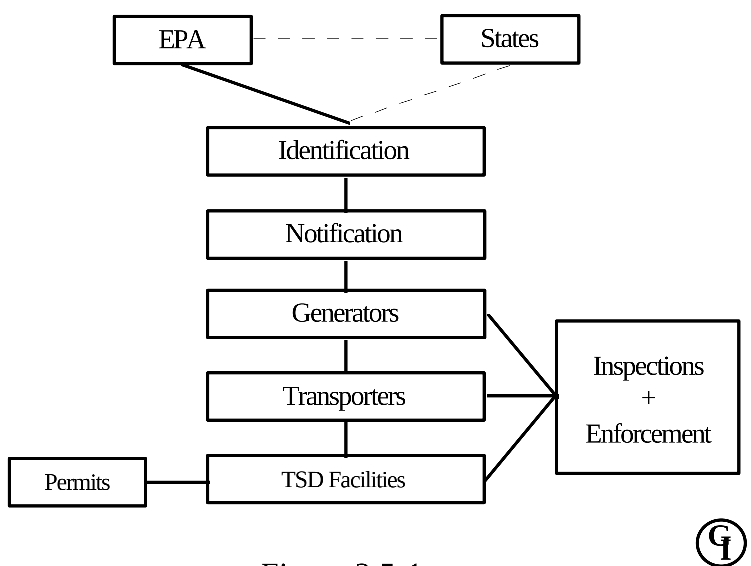

Figure 2.5-1
RCRA "Cradle To Grave" System

b. ***Discuss the requirements of 40 CFR Part 260, Hazardous Waste Management System - General, through 40 CFR Part 270, EPA Administered Permit Programs: The Hazardous Waste Permit Program, as applied to the field of environmental restoration.***

Applicability of RCRA to the Field of Environmental Restoration – 40 CFR 260-270 may all have some level of impact on the field of environmental restoration (ER), providing the ER activities have any hazardous waste associated with them. Following is a brief description of each of the 9 parts and an explanation of how these regulations may apply to ER.

- **Part 260** – Definitions of hazardous waste terms; procedures for rulemaking petitions; procedures for "delisting" a waste.
- **Part 261** – Regulations that specify whether or not a waste is hazardous; exemptions from the regulatory program; identification and listing of hazardous wastes.
- **Part 262** – Standards for hazardous waste generators.
- **Part 263** – Standards for hazardous waste transporters.
- **Part 264** – Standards for permitted treatment, storage, and disposal facilities.
- **Part 265** – Standards for interim status treatment, storage, and disposal facilities.
- **Part 266** – Regulations governing specific types of wastes -- typically those that are burned for energy recovery or are involved in recycling operations.
- **Part 268** – Regulations controlling the land disposal of hazardous wastes.
- **Part 270** – Regulations for obtaining hazardous waste permits; information requirements for Part A and Part B permit applications; description of "interim status".

ER activities are performed to address inactive hazardous substance disposal sites, whether deliberate or accidental. The universe of hazardous substances include RCRA hazardous wastes. If RCRA hazardous wastes are part of the contamination to be remediated, then RCRA probably applies.

The following is an excerpt from EPA's Memorandum 9347.0-1 entitled, *Interim RCRA/CERCLA Guidance on Non-Contiguous Sites and On-Site Management of Waste and Treatment Residue.*

"EPA interprets CERCLA to require that off-site treatment, storage, and disposal of hazardous wastes comply with all RCRA requirements, including permitting. With respect to on-site disposal, the National Contingency Plan requires that CERCLA activities meet the technical (substantive) requirements of RCRA (and other Federal environmental requirements) that are applicable or relevant and appropriate requirements (ARARs) while the procedural (administrative) requirements, such as permitting, need not be met."

EPA's Office of Solid Waste and Environmental Restoration (OSWER) Directive 9234.2-04FS states that, "RCRA Subtitle C requirements for the TSD of hazardous waste are applicable for a Superfund remedial action if:

- The waste is a RCRA hazardous waste, and either;
- the waste was initially treated, stored, or disposed of after the effective date of the particular RCRA requirement; or,
- the activity at the CERCLA site constitutes TSD, as defined by RCRA".

"RCRA requirements that are not applicable may, nonetheless, be relevant and appropriate, based on site-specific circumstances."

The RCRA regulations which have the greatest impact on ER hazardous wastes at DOE facilities are closure requirements and land disposal restrictions, as well as storage requirements.

c. Describe the requirements of 40 CFR Part 260, Hazardous Waste Management System - General, through 40 CFR Part 270, EPA Administered Permit Programs: The Hazardous Waste Permit Program, in applying for and developing Resource Conservation and Recovery Act permits.

See Section 2.5(b) above for a brief description of 40 CFR 260-270.

Many DOE facilities are operating under both interim status (Part A) and operating (Part B) permits. Any facility that at one time should have had an operating permit for the TSD of hazardous waste should have a Part A permit. If those TSD operations are shut down, EPA or the state will usually allow the facility to remain in interim status while it goes through closure of the operations of concern. If TSD operations are continuing, the interim status will have been changed to a full operating permit (Part B). Some facilities have both conditions existing at their site, such as Rocky Flats. The interim status is for numerous tanks and process lines that once contained or processed hazardous waste, but have since been shut down, awaiting or engaged in, closure activities. The existing TSD operations have moved on to get the Part B permit.

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[1] *Environmental Law Handbook*, 12th ed., Arbuckle, et. al., published by Government Institutes, Inc., Rockville, MD, 1993.

2.6 Environmental restoration personnel shall demonstrate a familiarity level knowledge of other environment-related laws and regulations.

Supporting Knowledge and/or Skills

a. Explain the purpose and application of the following documents to environmental restoration:

- **Endangered Species Act**

  The Endangered Species Act of 1973 establishes requirements to protect species of flora and fauna that are threatened by extinction and habitats important to their survival.

  Section 7 of the Act provides for Federal agency consultation with the U.S. Fish and Wildlife Service (USFWS) on any action which may result in the loss of sensitive species habitat or the actual taking of such species of plants or animals. Permits are required for the taking of listed species. "Taking" is defined to mean "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect."

  Compliance procedures:

  ◊ 50 CFR 17-endangered and threaten wildlife and plants, critical habitats
  ◊ 50 CFR 424-listing endangered and threatened species and designating critical habitat

  This Act applies to DOE facilities if ER operations, including cleanup, destroy habitat of these species.

- **National Historic Preservation Act**

  The National Historic Preservation Act (NHPA) establishes the National Register of Historic Places, the Advisory Council on Historic Preservation, the nationwide system of State Historic Preservation Officers (SHPO), and the consultation process. The goal of the Act is to promote the consideration, preservation, and management of cultural resources subject to any form of Federal jurisdiction (regardless of land ownership). Section 110 of NHPA encourages, among other things, pro-active planning for and management of cultural resources. Section 106 provides for Federal agency consultation with the SHPO on any action which may result in impact to eligible or listed (on the National Register) cultural resources.

  Compliance procedures:

  ◊ 36 CFR 60-National Register of Historic Places

◊ 36 CFR 63-Determinations of eligibility for inclusion in the National Register of Historic Places
◊ 36 CFR 65-National Historic Landmarks Program
◊ 36 CFR 79-Curation of Federally-Owned and Administered Archaeological Collections
◊ 36 CFR 800-Protection of historic and cultural properties.

DOE must document historic places and may not, in some cases, destroy such places during ER activities (i.e., decommissioning and deactivation).

- **Societal Regulations**

  Under the National Environmental Policy Act (NEPA) and the implementing regulations, socioeconomic, economic, public health and safety (including low-income and minority populations) impacts must be considered in environmental affects analyses.

  Also, see Environmental Justice and American Indian Religious Freedom Act of this section.

- **Native American Graves Protection and Repatriation Act**

  This Act, commonly known as NAGPRA, was enacted to address several aspects of how Federal agencies deal with certain sets of human remains, funerary objects (both associated and unassociated), sacred objects, and objects of cultural patrimony. NAGPRA essentially provides for the orderly transfer of ownership of certain of these remains and objects, found on public lands, to the appropriate Native American (and Native Hawaiian) tribes and /or individuals. If such items are found on DOE facilities, DOE must comply.

- **American Indian Religious Freedom Act**

  The American Indian Religious Freedom Act resolves that it shall be the policy of the United States to protect and preserve for the American Indians, Eskimo, Aleut, and Native Hawaiian the inherent right of freedom to believe, express, and exercise their traditional religions, including but not limited to access to religious sites, use and possession of sacred objects, and freedom to worship through ceremonial and traditional rites. DOE may not hamper site access, use, or possession of sacred objects.

- **Executive Order 12898-Environmental Justice**

  The general purpose of Executive Order 12898 is (1) to focus attention of Federal agencies on the human health and environmental conditions in minority communities and low-income communities with the goal of achieving environmental justice (EJ); (2)

to foster non-discrimination in Federal programs that substantially affect human health or the environment; and (3) to give minority communities and low-income communities greater opportunities for public participation and access to public information on matters relating to human health and the environment. The order requires Federal (i.e., DOE) agencies to identify and address disproportionately high and adverse human health or environmental effects resulting from its programs, policies, and activities on minority and low-income populations.

- **Pollution Prevention**

The Federal Pollution Prevention Act of 1990 (PPA) establishes pollution prevention as a national policy. The PPA requires the Environmental Protection Agency (EPA) to develop and implement a strategy to promote source reduction. Pollution that cannot be prevented should be recycled. If it is not feasible to prevent or recycle, then pollution should be treated. Disposal or other releases into the environment should be used as a last resort. The PPA defined pollution prevention to mean source reduction and other practices that reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, water or other resources or protection of natural resources by conservation.

The PPA also directs facilities subject to requirements of the Emergency Planning and Community Right-to-Know Act report of pollution prevention activities on toxic chemical release forms.

- **Waste Minimization**

DOE Order 5400.1, II(4)(b) requires field organizations to prepare a plan for a Waste Minimization Program. Program elements are to include:

◊ Goals for minimizing the volume and toxicity of all wastes that are generated, with annual reductions if programmatic requirements allow;
◊ Changes in waste quantity, volume, and toxicity that are achieved shall be compared with quantities generated in the previous year;
◊ Proposed methods of treatment, storage, and disposal that accomplish waste minimization and are technically and economically practicable, shall be reported as appropriate; and,
◊ Waste minimization plans required by specific legislation, such as RCRA, shall be included as a part of this program plan.

- **Price-Anderson Amendments Act**

The Price-Anderson Amendments Act (PAAA) renewed DOE's authority to indemnify contractors for public liability arising from a nuclear incident. As a condition of renewed indemnification and to ensure that contractor performance was consistent with prescribed standards, Congress also mandated a new DOE program, separate and apart from contractual award fees, to subject contractors to civil and criminal penalties for violations of DOE nuclear safety requirements.

The Price-Anderson Amendments Act of 1988 (PAAA) will be implemented by DOE through a series of rules in the Code of Federal Regulations (CFRs). The procedures for implementing and enforcing PAAA rules are set forth in 10 CFR 820; the enforcement policy is in Appendix A. Other rules include Nuclear Safety Management (10 CFR 830 series) and Radiation Protection (10 CFR 834 and 835).

b. ***Describe the purpose, and discuss the general significant requirements associated with the following environmental regulations:***

- **National Environmental Policy Act**

The National Environmental Policy Act (NEPA) of 1969 establishes a national policy to restore and enhance the quality of the human environment and to avoid and minimize any possible adverse effects of Federal actions upon the quality of the human environment, and establishes the Council on Environmental Quality (CEQ). The two objectives of NEPA are (1) to consider every significant aspect of the environmental impacts of a proposed action, and (2) to inform the public that the agency did indeed consider environmental concerns in its decisionmaking process. Section 101 of NEPA sets the goals, while Section 102 provides the means for carrying out the policy. Section 102 also contains "action-forcing" provisions (preparation of environmental impact statements) to make sure that Federal agencies act according to the letter and spirit of NEPA.

It is the policy of DOE to rely on the CERCLA process for review of actions to be taken under CERCLA, when practicable, and to address NEPA values and public involvement procedures under the CERCLA process.

Compliance procedures:

◊ 40 CFR 1500-1508-CEQ implementing regulations
◊ 40 CFR 1021-DOE implementing regulations

- **Natural Resource Damage Assessment**

Section 107 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) establishes responsible party liabilities for injury, destruction, or loss of natural resources. A damage assessment with associated compensation may be imposed for negative effects on natural resources. Recovered compensation, however, must be used to restore, rehabilitate, or replace the damaged resource. A group of trustees, usually including a state agency, administer this program with respect to DOE. DOE is a trustee as well as being potentially responsible for monetary damages.

Title 43 CFR, Part 11, "Natural Resource Damage Assessments", describes the procedures to be used by Federal and State agencies who are authorized to act as trustees of natural resources in their assessment of damages covered under CERCLA.

- **Toxic Substance Control Act**

The Toxic Substance Control Act (TSCA) regulates the manufacture and use of toxic chemicals. TSCA places on manufacturers the responsibility to provide data on the health and environmental effects of chemical substances and mixtures, and gives EPA comprehensive authority to regulate the manufacture, use, distribution in commerce, and disposal of chemical substances. The major objective of TSCA is to characterize and understand the risks that a chemical poses to humans and the environment before it is introduced into commerce.

TSCA generally bans the manufacture, use, and disposal of polychlorinated biphenyls (PCBs). TSCA also regulates the abatement of asbestos and radon in public buildings.

Compliance procedures:

◊ 40 CFR 763-asbestos
◊ 40 CFR 761-PCBs

- **Endangered Species Act**

See 2.6 (a).

- **National Historic Preservation Act**

See 2.6 (a).

- **Safe Drinking Water Act**

This 1974 Act (SDWA) provides for the safety of drinking water supplies by establishing and enforcing national drinking water quality standards. EPA has the authority to set drinking water standards and to approve appropriations from the states to assume primacy in the enforcement of those standards. Primary regulations govern public water supplies for the protection of health, and secondary regulations relate to taste, odor, and appearance of drinking water.

SDWA also extends Federal authority over groundwater quality through regulation of underground injection wells and sole source aquifers. If an aquifer is designated as a sole or principle drinking water source, Federal agencies cannot provide financial assistance to any program that may contaminate such an aquifer.

Under CERCLA, the health-based goals issued pursuant to the SDWA program are considered relevant and appropriate remedial standards for contaminated drinking water at Superfund sites. Many EPA Regions and states also use the drinking water standards for corrective action at sites under RCRA and solid waste regulatory authorities.

Compliance procedures:

◊ 40 CFR 142-implementation and enforcement of national drinking water regulations
◊ 40 CFR 124 -procedures applicable to permit programs

- **Clean Water Act**

The goal of the Clean Water Act (CWA) is to restore and maintain the chemical, physical, and biological integrity of the Nation's water. The CWA establishes numerous programs to be administered by the EPA (along with other Federal, state, and local agencies). These include the National Pollutant Discharge Elimination System (NPDES) permit program, the dredge and fill permit program, and municipal wastewater treatment programs. The goals of the act include elimination of the discharge of point source and non-point source pollutants into surface waters and achievement of a level of water quality which "provides for the protection and propagation of fish, shellfish and wildlife" and "for recreation in and on the water."

Compliance procedures:

◊ 40 CFR 401-effluent guidelines and standards
◊ 33 CFR 320-general regulatory policies
◊ 40 CFR 130-water quality planning and management
◊ 40 CFR 125-criteria and standards for NPDES
◊ 33 CFR 323-dredge and fill permits

- **Clean Air Act**

The goals of the Clean Air Act (CAA) are to protect and enhance the quality of the nation's air resources. The CAA establishes air pollution regulatory programs. First, all new and existing sources of air pollution are subject to ambient air quality regulations through source specific emission limits contained in state implementation plans. Second, new sources are subject to more stringent control technology and permitting requirements. Third, the Act addresses specific pollution problems, including hazardous air pollution and visibility impairment. The CAA also addresses moving pollution sources, noise pollution, and visibility.

The Federal government establishes air quality and emission standards, and the states determine how the standards are met. The EPA sets three different kinds of nationwide standards, including National Ambient Air Quality Standards (NAAQS) which define the maximum concentration of certain "criteria" air pollutants allowable in ambient air; New Source Performance Standards (NSPS) which establish allowable limitations for different kinds of new stationary sources; and National Emissions Standards for Hazardous Air Pollutants (NESHAP). Stationary and moving air pollution sources are regulated separately.

Compliance procedures:

◊ 40 CFR 50-general air programs
◊ 40 CFR 61- emissions standards for hazardous pollutants
◊ 40 CFR 60-new stationary sources

- **Atomic Energy Act**

The Atomic Energy Act of 1946 established the Atomic Energy Commission (AEC) to administer atomic energy materials and to pursue research, production, and development programs. The Act of 1946 required that the Federal government retain ownership of "source materials," which are defined as uranium, thorium, and ores containing these substances in concentrations established by the AEC. The 1946 Act also gave the AEC the power to control the possession and transfer of source materials.

The Atomic Energy Act of 1954 established a comprehensive program of licensing and regulation by the Federal government. The 1954 legislation authorized the AEC to license the construction and operation of facilities that produce and use special nuclear materials.

Radiation protection and radioactive waste management requirements issues under the Atomic Energy Act are implemented at DOE facilities as DOE Orders. DOE Order 5400.5, "Radiation Protection of the Public and Environment," establishes the standards and requirements for radiation protection of the public and the environment at DOE and DOE contractor facilities.

- **DOE Natural Resource Trustee Regulation**

Title 43 CFR, Part 11, "Natural Resources Damage Assessments," describes the procedures to be used by Federal and state agencies who are authorized to act as trustees of natural resources in their assessment of damages to natural resources resulting from a discharge of oil or a release of hazardous substances covered under CERCLA or the Clean Water Act. The process uses a planned and phased approach to the assessment. The approach is designed to ensure that all procedures used in an assessment, performed pursuant to this part, are appropriate, necessary, and sufficient to assess damages for injuries to natural resources. Phases include the preassessment phase, assessment plan phase, injury determination phase, quantification phase, damage determination phase, and post-assessment phase.

- **American Indian Treaties**

The Federal government and various bands and tribes of Indians entered into hundreds of agreements between 1787 until 1871. Treaty provisions differed widely , but it was common to include a guarantee of peace, a delineation of boundaries, a statement that the tribe recognize the authority or place itself under the protection of the United States, an agreement regarding the regulation of trade and travel of persons in Indian territory, and a provision for punishment of crimes between Indians and non-Indians. Important rights were guaranteed to the tribes, many of which continue to be enforceable today. Rights secured to the tribes by treaty include beneficial ownership of Indian lands, hunting and fishing rights, and entitlement to certain Federal services such as education or health care.

The United States government acts in a fiduciary or trust capacity in the management of Indian resources.

- **Executive Orders 11988 Floodplain Management and 11990 Protection of Wetlands**

The goal of Executive Order 11990 is to avoid to the extent possible the long- and short-term adverse impacts associated with the destruction or modification of wetlands, and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

The goal of Executive Order 11988 is to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains, and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

10 CFR 1022, "Compliance with Floodplains/Wetlands Environmental Review Requirements," establishes the procedures for floodplain/wetland determinations, for assessing impacts to floodplains/wetlands, and for public review of proposed actions that may impact floodplains/wetlands.

- **Noise**

Federal noise regulation is authorized under several statutory schemes, the most comprehensive of which is the Noise Control Act of 1972. The Act empowers EPA to undertake research on noise effects, provide technical assistance to state and local governments, and provide model state and local anti-noise legislation. EPA also establishes noise emissions standards for categories of equipment (e.g., construction and electrical equipment), for railroads and motor vehicles, and for aircraft noise and sonic boom. Other agencies also have significant authority over noise pollution, including the Occupational Safety and Health Administration (OSHA), for limits on work-related noise exposure pursuant the Occupational Safety and Health Act of 1970.

c. Describe the concept of "Applicable or Relevant and Appropriate Requirements" (ARARs) and how they relate to environmental restoration work.

Section 121(d) of CERCLA, as amended, establishes cleanup standards for remedial actions. This section requires that any applicable or relevant and appropriate standard, requirement, criteria, or limitation under any Federal environmental law (or any more stringent state requirement promulgated pursuant to a state environmental statute) must be met for any hazardous substance, pollutant, or contaminant that is to remain on site as part of a remedial action. A requirement promulgated under other environmental laws may be either "applicable" or "relevant and appropriate," but not both. Identification of ARARs must be done on a site-specific basis and involves a two part analysis: first, a determination is made whether a given requirement is applicable; if not, then a determination is made whether it is both relevant and appropriate. The EPA guidance also includes to-be-considered materials that are advisories and nonpromulgated guidance issued by Federal or state governments that are nonstatutory requirements evaluated along with ARARs as part of the risk assessment used to establish protective cleanup limits.

Remedial actions alternatives are evaluated against nine evaluation criteria for selection of a remedy under CERCLA. "Compliance with ARARs" is a "threshold" criteria which an alternative must meet in order be eligible for selection [40 CFR 300.430(f)(1)(ii)(C)]. The EPA may waive the ARAR and select a remedial action that does not attain the same level of cleanup as identified by ARARs.

ARARs include, but are not limited to, TSCA, SDWA, Clean Air Act, Clean Water Act, Marine Protection, Research and Sanctuaries Act, and Solid Waste Disposal Act.

4. MANAGEMENT, INSPECTION, AND OVERSIGHT

4.1 Environmental restoration personnel shall demonstrate a working level knowledge of technology evaluation.

a. Discuss the Department's policies and procedures for screening technologies

The Department has an overall policy that facility improvements and all other projects involving design and implementation of physical plants, cleanup/remediation and decommissioning of facilities for purposes of environmental restoration, be planned and designed in a manner that fosters:

- Functional effectiveness (meet environmental restoration objectives);
- Cost-effectiveness (including Life-Cycle Cost Analysis);
- Constructability (in accordance with appropriate Federal, state and local building codes); and,
- Ease of operation and maintenance over appropriate design life.

Life Cycle Asset Management (LCAM), DOE Order 430.1§(6e); and General Design Criteria, DOE Order 6430.1A§(0110)

These factors are incorporated into a design alternatives analysis, which is required before any physical asset is acquired (DOE Order 430.1) or any facility design is implemented (DOE Order 6430.1A). The design alternatives analysis is a cornerstone process that is used throughout the DOE complex as one means to continual improvement in the Department's business practices. Such an analysis is applied in the environmental restoration (ER) program whenever ER infrastructure improvements (treatment and storage units), cleanup of soil, waste or groundwater, or decontamination and demolition (decommissioning) of facilities are planned and designed. Examples of types of ER activities are:

- Contaminated media/waste management facilities-groundwater and wastewater treatment plants; air pollution control units; contaminated media and solid, hazardous and radioactive waste packaging, treatment and disposal facilities; in situ groundwater and soil cleanup and immobilization systems, decontamination units, and removal technologies, etc.;
- Environmental monitoring systems; and,
- Decommissioning of waste management and industrial production facilities.

Evaluating of a range of technologies for accomplishment of media/waste management, monitoring or decommissioning objectives is a key element of the design alternatives analysis process. The technology evaluation feeds vital information into the design alternatives analysis about the technical feasibility, cost and implementability of a range of potentially suitable technologies, which is then used in the alternatives analysis. These steps are usually taken during or before Title I design is completed for an ER infrastructure, cleanup or decommissioning project, which is the planning and conceptual design stage in accordance with DOE project management guidance in DOE Order 4700.1 (Chapter V).

Life Cycle Asset Management (LCAM, DOE Order 430.1) is phasing out Order 4700.1 as the Department's requirement for project management. However, LCAM entails a project-specific "necessary and sufficient" process for identification of project management and scoping requirements. The provisions of Order 4700.1 for project staging (Title I, Title II, Execution, etc.), which include the alternative analysis process with technology evaluation, are considered necessary guidance for the performance of environmental restoration (ER) projects. Requirements for remediation project analysis and selection from other Federal and state agencies also apply to ER project technology evaluations conducted by the Department.

Additional requirements that guide the planning and conceptual design of ER projects and call for alternatives analysis and technology evaluation are contained in the U.S. Environmental Protection Agency (EPA) National Contingency Plan (NCP; 40 CFR Part 300) of CERCLA, the EPA RCRA Corrective Action Program (40 CFR 264, Subpart F) and authorized state hazardous waste programs. These other Federal and state requirements are applicable at DOE Weapons Complex Sites through:

- An array of DOE orders and policies:
  - ◊ DOE Order 5480. IB: Environment, Safety and Health Program for Department of Energy Operations;
  - ◊ DOE Order 5400.3: Hazardous and Radioactive Mixed Waste Program;
  - ◊ DOE Order 5480.14: Comprehensive Environmental Response, Compensation, and Liability Act Program; and,
  - ◊ U. S. DOE and EPA, Policy on Decommissioning Department of Energy Facilities Under CERCLA, May 22, 1995.
- The DOE "Decommissioning Resource Manual," August, 1995;
- Executive Order 12088: Federal Compliance with Pollution Control Standards; and,
- Federal Facilities Compliance Act.

CERCLA National Contingency Plan (NCP) Requirements. The CERCLA NCP establishes processes of remedial investigations and feasibility studies (Rl/FS) for the characterization of contaminated sites and facilities and the development of remedial action plans (RAPs). Technology evaluation and alternatives analysis are cornerstone procedures in the FS process for technology screening and selection of RAPs.

Initially, the need for remediation is scoped and candidate technologies and cleanup approaches are screened. Infeasible technologies and alternatives are screened out of further consideration by comparisons of their expected effectiveness, implementability, and order-of-magnitude costs. These **screening criteria** are assessed as follows:

- Effectiveness - A preliminary evaluation of whether the cleanup technologies have the potential to achieve the remedial objectives of the cleanup, including risk reduction and compliance with cleanup standards;
- Implementability - Technical and administrative feasibility of implementing the technologies. Technical factors include availability of the technology or key equipment/materials required for its implementation, ease of construction and post construction requirements (such as management of hazardous or mixed treatment residues). Administrative feasibility deals with permits, approvals, consultation and coordination necessary for implementation; and,
- Costs - Present worth costs based upon order-of-magnitude estimates of the costs to implement the remedy, both capital and operating; used to discern between technologies only when the other screening criteria fail to distinguish the most favorable technologies and alternatives for achievement of cleanup objectives.

The **threshold criteria** in the NCP detailed analysis process used for final selection of remedial technologies and the RAP are as follows:

- Overall Protection of Human Health and the Environment - Reduction of human health risk and environmental impacts by achievement of remedial action objectives; and,
- Compliance with Cleanup Requirements - Meet requirements established for the project for each chemical contaminating environmental media and waste, for each remedial action measure, and for each location where remedial action is proposed.

Additional **primary balancing criteria** that help guide the identification of a RAP that has effectiveness, permanence, and minimizes residual risks both on and off the site are as follows:

- **Long-Term Effectiveness and Permanence** - Risk reduction, adequacy and reliability of controls on the remedial technologies to avoid re-release problems;
- **Reduction of Toxicity, Mobility and Volume Through Treatment** - Allows the contrasting of treatment-technology-based alternatives against removal/disposal alternatives, which transfer the hazardous contaminants to another location where a threat of re-release is created;
- **Short-Term Effectiveness** - Addresses health risks and environmental effects during remedy implementation and compares the time to achieve remedial action objectives, which contrasts between treatment-based alternatives and those which only offer containment of contaminants;
- **Implementability** - Technical and administrative feasibility of technologies and availability of services and equipment that are necessary for implementation; and,
- **Costs** - Capital/construction, operation and maintenance, and present worth costs for comparison of alternatives.

State and community acceptance are modifying criteria that are also applied near the end of the planning and conceptual design process, consisting of Federal and/or state regulatory agency review and public comment processes to assess acceptance of the selected technologies and RAP.

Technology evaluation and alternative analysis under CERCLA for decommissioning of the Department's nuclear production and industrial operations are conducted under modified criteria for "non-time critical removal actions" in accordance with the above referenced DOE policy and Decommissioning Resource Manual. The abbreviated technology evaluation and alternatives analysis for decommissioning projects entails the identification of technologies and alternatives for decommissioning to address hazards and health risks identified for the candidate building or process area. Then, the selection analysis involves only overall effectiveness, compliance with requirements, and cost comparisons. The selected technologies and plan for decommissioning must also be consistent with any other long-term remedial actions planned for the same facility or underlying contaminated media.

RCRA Corrective Action Program Requirements - RCRA Corrective Action Program requirements mandated by EPA regulations, 40 CFR 264, Subpart F parallel those for CERCLA remedial action. The RCRA corrective action requirements apply to releases of hazardous waste and toxic constituents from solid and hazardous waste management units at sites with **actively managed hazardous waste facilities**, whereas CERCLA remedial action addresses contamination from **past management of hazardous waste and toxic chemicals.** The evaluation of technologies and analysis of alternatives emphasize on-site management, consolidation and treatment of hazardous wastes and contaminated media. The analysis is conducted as a part of the Corrective Measures Study (CMS), which is equivalent to the FS under the CERCLA NCP. The analysis requirements are similar for the RCRA and CERCLA programs and, at some sites such as the Rocky Flats Environmental Technology Site, the analyses are integrated into one decision process for locations and units that are covered by both programs.

State Program Requirements - States may have equivalent programs for CERCLA and/or RCRA which give the authorized state agency primacy for review of the technology evaluation and alternatives analysis. State requirements are always as restrictive or more restrictive in the depth of analysis required and the criteria used in evaluation and acceptance of the recommended technologies and remedial or corrective action plans.

b. Describe the process for performing a Cleanup Alternative Analysis.

In the context of ER projects, technology and alternatives analyses are usually conducted within the framework of the equivalent CERCLA or RCRA regulatory processes described in Section 4.1 (a). The technical, cost and effects analyses developed to satisfy

NCP FS or RCRA Corrective Action requirements then also are used to satisfy the project planning and management requirements in DOE 4700.1 and DOE Order 430.1 [Section 4.1 (a)] the same as for EC projects presented in this study guide [Section 4.6(b)]. The CERCLA process for Cleanup Alternative Analysis (CAA) is presented below. The reader is referred to the Environmental Compliance Study Guide [Section 4.6(b)] for the DOE requirements for technology evaluation in the context of design alternatives analysis.

Remedial Investigations (RI) Data and Cleanup Objectives- Key information is taken from the RI report and will have been assembled for use in the CAA, including hazardous waste and contaminated environmental media characteristics and quantities, and other key data on the nature and extent of media contamination. Examples of the data summaries and key remedial design parameters that are reviewed and used in the CAA include summary statistics for hazardous constituents in groundwater, soil and waste, geological conditions in the areas of disposal and contamination, and hydrologic characteristics of contaminated groundwater.

The RI or another document will provide documentation on the health and environmental risks associated with each area of contamination and its characteristic hazardous constituent concentrations. A set of remedial action objectives (RAOs) and priorities is developed based upon site characteristics and health and environmental risks. The RAOs are usually stated very generally to allow consideration of a wide range of potentially applicable technologies and alternatives; e.g., remediate surface soils in source area X, control source area X groundwater to contain the plume.

Finally, an analysis of applicable or relevant and appropriate requirements (ARARs) will have been performed providing, among other information, numeric requirements for hazardous and toxic contaminant concentrations allowable in environmental media or waste; e.g., state groundwater quality standards, state surface water quality standards. These ARARs will have already been used to assess the extent of contaminated media and wastes that require remedial action. They will also help define the extent and completeness of remediation that the technologies and cleanup alternatives must achieve to successfully address the RAOs; e.g., treated groundwater from source area X discharged to surface waters in accordance with state surface water quality standards and U.S. EPA effluent limitations for discharge to surface water.

These data and information sources must be reviewed and understood at the outset of the CAA screening process so that applicable, potentially effective technologies and remedial alternatives can be identified.

Identification of General Response Actions and Technologies- The EPA FS procedures call for identification of General Response Actions (GRAs) that address each RAO before technologies are identified and cleanup alternatives are formulated and screened. The GRAs are very generally stated approaches to remediation that are matched with the RAOs; e.g., containment of source areas, treatment of wastes and/or contaminated media. More than one GRA may be selected as applicable to a given RAO, or a single GRA may be selected for which multiple technologies are applicable. The objective in selecting GRAs for each RAO is to attain full coverage of all RAOs with

GRAs that will lead into a successful CAA, but without producing an unnecessarily cumbersome, voluminous analysis process involving an excess of options.

Once GRAs are established, a number of potentially effective technologies are listed for each GRA that may be effective at the specific site, and for the specific types of wastes, media, and hazardous constituents. At large sites with more than one area requiring this first-cut analysis, a site-wide technology identification and screening process can be conducted that assesses the applicability of technologies to the overall suite of contaminants at the site, the site geology and hydrology, and other relevant factors with site-wide scope and applicability. The lists of technologies can be drawn from a wide variety of sources, including DOE and EPA guidance, technical journal publications, vendor literature and contacts, and university studies. More information on technologies is presented in the Technology Studies step below.

The output of this step will be listings or a matrix that match GRAs and potentially applicable technologies with each RAO identified in the earlier steps. These groupings are then subject to a screening alternatives analysis in a later step.

Technology Studies- The technologies that could be incorporated into the various options are assessed in a state-of-the-art analysis which draws on:

- Reported experience in the Complex (e.g., DOE's ER Technology Information Exchange), other government administered programs (e.g., Department of Defense installations, municipal wastewater treatment and solid waste disposal facilities) and in industry (e.g., nuclear power generating stations);
- Emerging/innovative technology development studies and demonstration programs (e.g., EPA's Technology Transfer and Superfund Innovative Technology Evaluation programs; DOE's Remedial Action Program Information Center); and,
- Federally mandated technology-based compliance program documentation (e.g., EPA and development documents supporting categorical effluent limitations for industrial wastewater effluents; EPA Clean Air Act regulations for air pollution control technology).

Prior to the criteria analysis and selection, additional technology study may be conducted to accomplish two objectives:

(1) Develop a more detailed assessment oftechnical feasibility and costs; and,
(2) Obtain design criteria, either of general applicability or direct applicability to the site-specific and installation-specific conditions.

Such technology studies may take a number of forms and require varying time and funding commitments. The level of detail could involve a range of approaches and complexity. Further literature review could be conducted and contacts made with technology developers and practitioners. Field trips could be made to inspect existing and in-construction installations. During the site visit, performance and cost data would be obtained from technology suppliers and/or the owner. Laboratory and/or field pilot tests, known as treatability studies, may be conducted on the technology either on-site or in a remote test facility.

Technology studies may also be incorporated into the project after the alternatives analysis is complete if the objectives are to demonstrate the effectiveness of a selected innovative technology and/or obtain design criteria for the selected remedy prior to detailed (Title II) design.

Screening Analysis - Technologies are combined as necessary to form options which could fully address each RAO taking the general approaches to remediation represented by the GRAs. Brief descriptions of each option are prepared and order-of-magnitude cost estimates are prepared for the major cost factors of each option. The options and technologies are evaluated using the three criteria in Section 4.1(a). The analysis allows for identification of a manageable number of remediation alternatives and technologies for detailed analysis. The screening analysis may by summarized in a matrix of screening criteria ratings. If developing technologies are selected, this may be a decision point on whether in-depth technology studies are needed as described in the preceding paragraph to support the detailed analysis or generate design criteria.

Develop Alternative Descriptions - The screened technologies and GRAs are subjected to further technical and cost analysis to produce the alternatives that receive NCP remedial action criteria analysis. Uncertainties about the effectiveness of technologies and the scale and costs of alternatives are resolved. Conceptual designs are made complete using engineering analysis and treatability data from technology studies. Cost estimates are refined. Depending on the number of alternatives and technologies, these analyses may be carried to the Title I design level for both design development and cost methods, detail, and accuracy. Preferably, the greater level of detail to produce a Title I design should be delayed until the selected remedy is chosen and then the Title I information is generated only for the selected RAP. Agreement should be sought with the regulatory agency on this approach. In parallel and in accordance with requirements of other ER skills areas, future health and ecological risk analyses are performed that feed into the criteria analysis for each alternative.

Criteria Analysis - Although the technologies and alternatives which pass screening are those which are expected to meet the threshold criteria [Section 4.1 (a)] for selection as the RAP, the more detailed information from the development of alternatives step is used along with future risk information to perform a threshold criteria analysis. If alternatives are identified that do not meet the threshold criteria (i.e., do not achieve RAOs and meet cleanup requirements/ARARs), then additional alternative development may be performed to assure that alternatives are included in the detailed criteria analysis that utilize each selected GRA. The NCP mandates detailed consideration of alternatives that employ treatment, immobilization, and on-site consolidation and disposal GRAs as well as removal and off-site management GRAs.

A primary balancing criteria analysis is performed to compare and contrast the relative merits of the alternatives per the listing of criteria in Section 4.1(a). Cost-effectiveness, implementability and short-term effectiveness are contrasted with permanence and reduction of toxicity mobility and volume of contaminated materials and key, favorable technologies are selected.

The modifying criteria analysis, consisting of getting regulatory agency and public input to the criteria analysis, is usually conducted as requirement of the NCP after the threshold criteria and a first-cut primary balancing criteria analysis are completed. In formal NCP-driven ER projects, the concems raised by the public must be formally addressed in a responsiveness summary.

Decision Analysis- The criteria analysis of the preceding step is summarized in a matrix, with detailed supporting text to explain the relative subjective rankings assigned to the altematives. Public concerns that relate to the potential effectiveness and protectiveness of the selected RAP or the factors used to reject other alternatives may require the re-analysis of the remediation technologies prior to final RAP selection and acceptance by regulatory agencies. Selection of a RAP that is less favorable based upon primary threshold criteria and long-term effectiveness and permanence must by justified and receive a waiver of NCP requirements from the lead regulatory agency, usually the EPA region.

Selected Cleanup Alternative and Technologies The selected alternative and technologies are incorporated into a "proposed plan" for site remediation that addresses the schedule and implementation requirements for the RAP. At this point, Departmental guidance requires a design level of detail equivalent to Title I, so that the proposed plan can be combined with project planning documentation required in DOE Order 4700.1 (applicable per the necessary and sufficient process of DOE Order 430.1) and used to gain approval to commence the execution phase for the technologies included in the selected cleanup alternative. If needed to support the remedial design, an additional technology study may occur; e.g., a treatability study to help establish the design criteria for a technology. Design criteria are a Title I deliverable. The proposed plan also is used to obtain final regulatory agency approval for implementation of the selected cleanup alternative.

c. Conduct a technology evaluation using a Cleanup Alternative Analysis.

The conduct of a CAA is a demonstration skill and environmental restoration personnel will actually be performing the evaluation rather than acknowledging comprehension. To assist in performing the evaluation, key points of the NCP process are emphasized and proper techniques and strategies for successful technology evaluation and alternatives analysis are described below to aid in development of this skill. The presentation of these key points, techniques and strategies is organized and presented in the format of the CAA process in Section 4.1(b).

Identification of General Response Actions and Technologies - A key to successful and timely completion of CAAs in accordance with the CERCLA NCP is **FS scoping.** As early as the period when RI activities are initiated to investigate the sources and nature and extent of contamination at the site, the personnel responsible for the FS and evaluation of technologies should be involved in the planning and begin identification of GRAs and technologies for the known nature of sources and contaminant migration. The benefits of this approach are:

- Focus site investigations to acquire site data necessary for technology evaluation and alternatives analysis;
- Early prioritization of technologies and alternatives, so that technology studies can be planned and executed in a timely manner. If technology studies are needed to support alternatives analysis, starting those studies during scoping will better allow for completion in a time frame that will effectively support the screening and detailed alternatives analysis; and,
- Involvement of the regulatory agency in the scoping process will help in bringing consensus on the appropriate and viable GRAs and technologies.

Technology Studies - The Department's sites and facilities tend to be large in area and typically have more than one environmental restoration project for remediation of sources and plumes of contamination. These characteristics lend themselves to: (1) integration of technology studies and (2) use of initial technology suitability analyses on multiple feasibility studies. Integration can be achieved by the conduct of site-wide, technology needs assessments and developing technology identification studies. Technology suitability analyses can be conducted once for the various types of contaminants and subsurface conditions that occur across the site and the output used with only minor adaptation on numerous technology identification and screening exercises for the various FSs required at the site.

Detailed planning and engineering to employ a developing technology should be undertaken only after thorough research into existing applications of the technology. Networking on technology application experience at other DOE sites, government sites, and on private sector cleanups can be effectively initiated using the DOE and EPA programs listed in Section 4.1(b). Technologies with proven track records should be given preference for evaluation unless unique contamination problems or site conditions exist that are only addressed by developing technologies.

Deferral of in-depth technology studies involving costly treatability studies and large-scale demonstrations is the preferred approach if these data are not needed for alternative analysis. Later in technology evaluation and alternative selection, needs for in-depth data can be better focused to produce a cost-effective program. After selection of the cleanup alternative, the in-depth technology study can be scoped to produce only the data needed for key technology effectiveness and design criteria questions that remain for either the Department or regulatory agency.

Screening Analysis- The practical purpose of screening is to produce a manageable number of potentially feasible alternatives and technologies for detailed criteria analysis. Each technology that is without serious effectiveness and implementability flaws does not necessarily have to be included in the final list of alternatives subjected to criteria analysis. Cost and the site-specific knowledge of the environmental restoration personnel preparing the CAA should guide the technology selections. GRAs must be identified and used as the basis for alternatives development that address the RAOs. At this stage, involvement of the regulatory agency in the review of the screening results is important and helps in later consensus-building for the selected cleanup alternative.

Criteria Analysis- Thorough understanding of the threshold and primary balancing criteria is crucial to the preparation of a good criteria analysis; the NCP language should be carefully reviewed to make sure the criteria are used properly in the analysis. There are several EPA guidance memoranda for the criteria and their use in remedy selection in various circumstances. A failure-risk perspective should be employed when comparing alternatives that utilize different means of controlling or eliminating contamination. For example, technologies that are innovative ways of reducing the toxicity, mobility, and volume of contaminated media may have had only limited success at other sites. This means that there is probably a risk of failure that should be factored into the comparison of these alternatives against alternatives that employ more tested, proven technologies.

The concept of cost sensitivity carries the failure-risk approach into the realm of cost-effectiveness analysis and should be part of the cost criteria analysis. Costs estimates used in the alternatives analysis are never highly accurate and accuracy may vary among the alternatives due to varying levels of design detail available for the estimate. Furthermore, the risk that design criteria and assumptions are incorrect may vary and the impact of those uncertainties on total present worth costs of the alternatives may also vary. A classical example is remediation of contaminated soil areas that are sources of groundwater contamination. An alternative that employs soil removal and off-site shipment and disposal may appear cost-effective for a given quantity of soil estimated to require remediation. An alternative which involves on-site soil treatment of the soil and returning the soil to the excavation for disposal may appear more costly. However, unit costs for on-site soil treatment are usually highly sensitive to the quantity of soil to be remediated due to high, fixed mobilization and setup costs. Unit costs for off-site shipment and disposal are usually constant once the quantity of soil rises above that required for one full load. The cost sensitivity of the two alternatives to soil quantity must be factored into the cost comparison by assessing how variable the soil quantity might be due to the level of detail in the soil investigation that defined extent of contamination. This example also is appropriate to situations where the soil cleanup requirements (concentration levels in soil) could vary.

Decision Analysis- A key to successful decision analysis (an analysis that points to a protective, cost-effective, implementable RAP) is the development of clear-cut, understandable arguments for the ratings of alternatives and technologies with respect to the threshold and primary balancing evaluation criteria. Numerical modeling may be used to evaluate the efficiency of a technology, the effects of its implementation upon the spread of contamination or the resultant health risk benefits. If so, the following guidelines should be followed in using modeling results in the decision analysis:

- Any models used should be reviewed with the regulatory agency to assess whether it is accepted or known by the agency. The need for parallel, corroborating analyses or familiarization techniques to strengthen confidence in the model output should be identified well before the decision analysis is performed. Many treatment technology developers and vendors supply computer-based design, treatment performance and cost programs that may be unique to that technology type and source but employ common calculation techniques. If a particular technology is expected to be favored in the decision analysis and/or is central to the success of the probable RAP, it will be advisable to provide information to the regulatory agency and perhaps schedule an office visit or field trip for regulatory agency personnel to meet the vendor, review the model used in design, and view a technology model demonstration.

- Detailed model results in the form of computer printouts must be accompanied by explanations of the calculation methodologies, input parameters, validation techniques and results, and interpretation of the model output in terminology that will be familiar to non-experts. This detailed information should be appended to the FS report.

- In the FS text on alternative development and decision analysis, the model should be briefly explained and key results summarized, rather than referencing the appended detailed description for all information.

Selected Cleanup Alternative and Technologies- A key point regarding presentation of the selected cleanup alternative and technologies is the level of design provided. In the context of Departmental requirements for completion of Title I and Title II design on projects, the FS and RAP phase culminating with the issuance of the proposed plan for environmental restoration projects takes the place of and must provide the level of detail commensurate with Title I design. However, that level of detail, which includes a preliminary cost estimate with ±30% accuracy, is not required for all alternatives and technologies but only the *selected RAP*. The Title I design provided for the selected alternative and technologies should not be extended to include any part of the Title II design scope. Detailed Title II design information that is incorporated into the proposed plan with a Title I design may have to be changed later during the formal Title II design, and could require a re-opening of the CERCLA NCP decision process to make changes in the proposed plan.

d. ***Discuss the methods and importance of keeping accurate administrative records.***

The Records Management Program, DOE Order 1324.5B, requires the implementation of a Department-wide records management program that provides for adequate and proper documentation, records disposition in compliance with the National Archives and Records Administration Act of 1984, and economy and efficiency. In accordance with DOE Order 1324.5B, the DOE will ensure that contracts requiring implementation of a records management program will comply with relevant Federal laws and regulations. Records refer to those classess of documentary materials that may be disposed of only after archival authority is obtained. The statutory definition of"records" (44 U.S. Code 3301) is "books, papers, maps, photographs, machine readable materials, or other documentary materials regardless of physical form or characteristics."

Environmental restoration projects will usually be carried out under the CERCLA NCP, RCRA Corrective Action Program, or an equivalent state program, all of which require maintenance of an Administrative Record (AR) of the project. The FS process, which entails technology evaluation and the CAA, is part of the AR and includes the results of agency and public review of the decision analysis and selected alternative. The AR for an NCP project must be maintained for three years after the issuance of the Record of Decision on the proposed plan by the regulatory agency and must be accessible to the public.

An adequate records program contains documented evidence of scientific and administrative work to support a project and project decisions. Important technology evaluation and CAA information that should be maintained in the AR includes:

- Scoping process results and correspondence with regulatory agencies;
- Technology files, including vendor information, modeling programs and results, technology analysis, treatability information, and cost estimates;
- Technology screening process information, including basis for criteria analyses and evaluation matrix;
- Alternative design and effectiveness analyses, cost estimates, and modeling programs and results;
- FS documents published for public review;
- Cost-effectiveness and sensitivity analysis calculations; and,
- Correspondence from agency and public reviews.

Adequate records management provides a history of the results of the technology evaluation and CAA that may provide background information to guide additional FS work for the same site, technologies, and response actions. For example, since the Department's sites and facilities tend to be large in area and typically have more than one environmental restoration project, adequate documentation for one project concerning why a developing technology was chosen over technologies with proven track records can assist technical staff assigned to similar projects in their assessment of which technologies to investigate.

An efficient records management system ensures that records are captured in a timely fashion. Records need to be complete, correct, and legible. Additionally, records need to be protected from possible damage and the resultant loss of needed information. Because records requirements will vary from project to project, individuals need to check with their supervisors regarding specific records management methods.

4.2 Environmental restoration personnel shall demonstrate a familiarity level knowledge of the structure of the Environmental Management (EM) organization, specifically including the Offices of Environmental Restoration, Waste Management, and Technology Development and any other applicable sub-element(s).

Supporting Knowledge and/or Skills

a. Given the current Environmental Management organization chart, explain the relationship between the organizational elements and describe the functions of each element:

The current relationship of the organizational elements of the Environmental Management (EM) organization are shown in Figure 4.2-1. The functions of these organizational elements are described below.

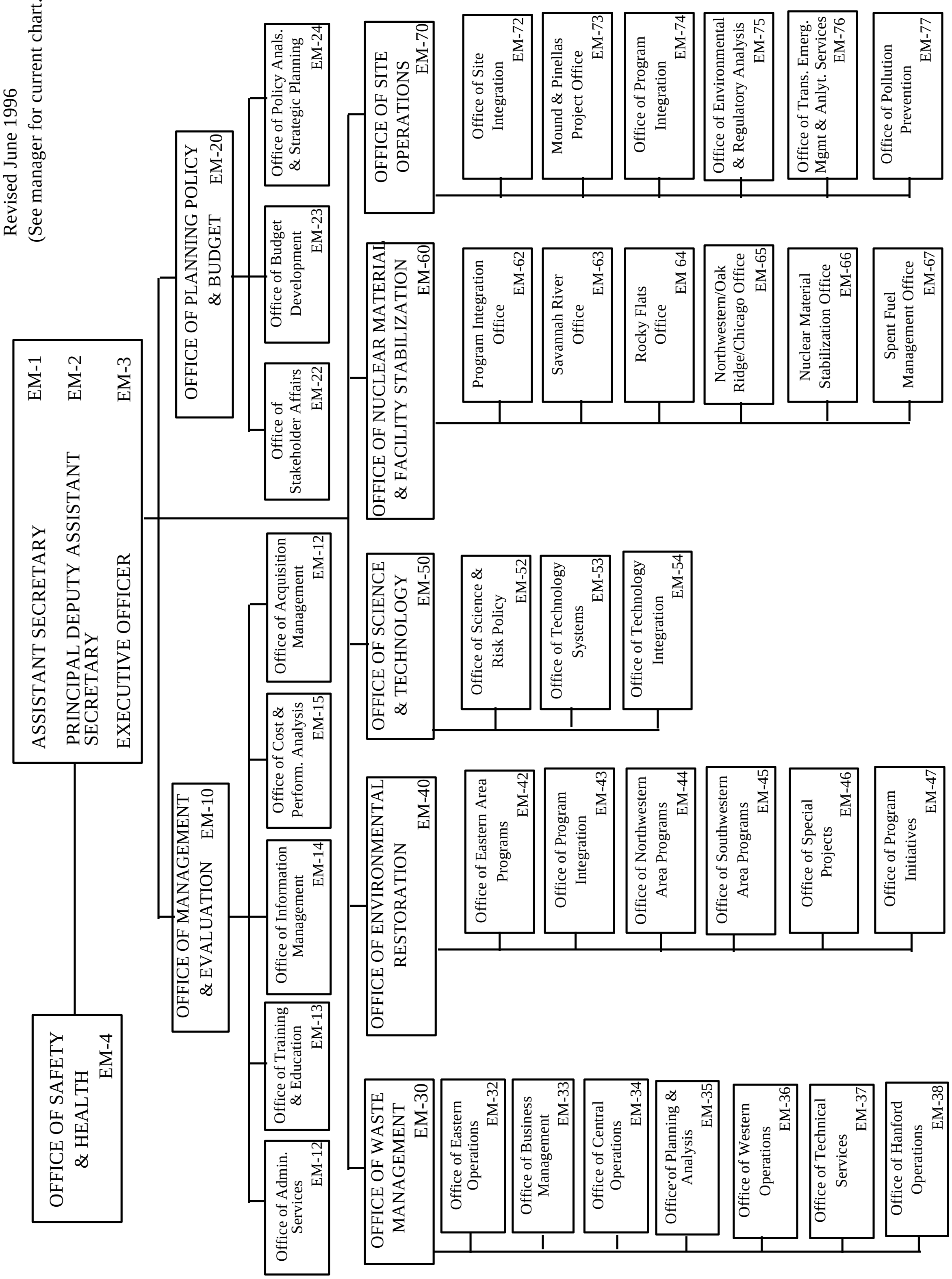
The **Office of the Assistant Secretary for Environmental Management (EM-1)** provides program policy development and guidance for the assessment and cleanup of inactive waste sites and facilities, and waste management operations; develops and implements an aggressive applied waste research and development program to provide innovative environmental technologies to yield permanent disposal solutions at reduced costs; and oversees the stabilization of nuclear materials, the management of spent nuclear fuel and the deactivation of facilities deemed to be surplus to their original mission. The Assistant Secretary provides centralized management for the Department for waste management operations, environmental restoration, nuclear materials and facility stabilization, and related applied research and development (R&D) programs and activities, including the EM program policy guidance to all DOE Operations Offices in these areas. These responsibilities do not include Nuclear Waste Fund activities which are managed separately by the DOE Office of Civilian Radioactive Waste Management (OCRWM).

The **Office of Safety and Health (EM-4)** is responsible for issues associated with environment, safety, and health. Under the Deputy Assistant Secretary for Environment, the Office of Safety and Health has responsibility for environmental compliance; environmental guidance, including RCRA/CERCLA and air, water and radiation issues; environmental audit; and NEPA oversight. The Office of Safety and Health represents the Assistant Secretary for Environmental Management to develop and implement an integrated safety and health program, upgrade the safety posture on the Environmental Management (EM) facilities and operations, and address urgent risk issues.

The **Office of Management and Evaluation (EM-10)** serves as the Assistant Secretary's principal advisor on all administrative functions and activities for line offices within the Office of the Assistant Secretary for Environmental Management (EM). These activities cover administrative management, such as personnel administration and general administrative support services (including domestic and foreign travel); training and career development; total quality management (TQM); organization and manpower management;

Figure 4.2-1
OFFICE OF ENVIRONMENTAL MANAGEMENT

Revised June 1996
(See manager for current chart.)



cost and performance management; space and logistics management; acquisition, procurement and contracts management; and automatic data processing (ADP), automated office support systems (AOSS), and information management (IM).

The **Office of Planning, Policy and Budget (EM-20)** provides critical analysis and other support to the Assistant Secretary and throughout the executive branch on policy and planning issues associated with environmental compliance and cleanup activities, waste management, nuclear materials and facilities stabilization, overall budget and priority setting analyses, nuclear non-proliferation policy practices, and for the ultimate disposition of surplus materials and facilities. The Office is also responsible for the review, coordination, and integration of inter-site, inter-agency and international planning activities related to these issues. Finally, the Office coordinates policy and procedural issues associated with the external regulation of the environmental restoration, waste management and nuclear materials and facility stabilization programs.

The mission of the **Office of Waste Management (EM-30)** is to protect people and the environment from the hazards of DOE wastes by providing an effective and efficient system which minimizes, treats, stores, and disposes of DOE waste as soon as possible. As such, the Office provides for the leadership necessary to accomplish the mission and carries out those program planning and budgeting, evaluation and intervention, and representation functions associated with management of radioactive high-level, transuranic, and low-level waste; hazardous and sanitary waste; and mixed waste. This does not include materials for nuclear materials or weapons production, or facilities, operations, or sites under direction of the DOE Office of Civilian Radioactive Waste Management.

The mission of the **Office of Environmental Restoration (EM-40)** is to protect human health and the environment from the risks posed by inactive and surplus DOE facilities and contaminated areas by remediating sites and facilities in the most efficient and responsible manner possible in order to provide for future beneficial use.

Office of Science and Technology (EM-50) is responsible for managing and directing focused, solution-oriented national technology development programs to support the DOE Office of Environmental Management. These programs involve research, development, demonstration, testing and evaluation activities that are designed to provide innovative technologies and technology systems to meet end-user's needs for regulatory compliance. Science and technology activities include coordination with other stakeholders and the private sector, and collaboration with international organizations, using a systems-approach to reduce waste management life cycle costs and risks to the environment and people. The Department's Risk and Science Policy Program will also be managed from this Office.

The mission of the **Office of Nuclear Material and Facility Stabilization (EM-60)** is to protect people and the environment from the hazards of nuclear materials and to deactivate surplus facilities in a manner which provides savings to the government by providing an effective and efficient system which stabilizes nuclear materials and deactivates as soon as possible. As such, the Office provides for the leadership necessary to accomplish the mission and carries out those program planning and budgeting, evaluation and intervention, and representation functions associated with the stabilization of nuclear materials and the deactivation of surplus facilities.

The mission of the **Office of Site Operations (EM-70)** is to operate as a focal point and champion in EM for the operations offices and field sites by providing leadership for cross-cutting issues and topics raised by the field and/or EM Headquarters and by serving as facilitator, ombudsman, and/or coordinator. The Office of Site Operations will ensure that issues requiring EM and DOE Headquarters review, concurrence, resolution, or other decisions are acted upon quickly, corporately, and equitably. The Office of Site Operations will provide headquarters policy direction for landlord planning and budgeting including reducing site infrastructure costs and managing workforce restructuring. Further, the Office will provide policy and guidance to improve the effectiveness of crosscutting environment, transportation management, and waste minimization activities. The Office will act as advocate to ensure the field dimension is recognized in major EM decisions and eliminate barriers to excellent performance.

b. ***Given a current Department organization chart, explain the relationships between Departmental elements and environmental restoration.***

The current organization chart (Figure 4.2-2) for the Department shows nine elements under the Secretary of Energy.

The **Inspector General** is responsible for assuring that all applicable regulations, policies, and other requirements are implemented. The Inspector General conducts audits of all offices in the Department on a periodic basis to identify any areas of non-compliance. Environmental audits assure that the field offices are compiling requirements of such laws as RCRA regarding classification, storage, and disposal of hazardous wastes, permits required under such laws as the CWA, and other requirements

The **General Counsel** is responsible for providing legal advice. The General Counsel reviews agreements and commitments made by the Department and provides legal advice regarding these agreements. It determines the extent of legal liability resulting from actions taken. It advises the Department and its offices in legal matters during negotiations and disputes with regulatory agencies, stakeholders, and other parties such as contractors and litigants. The General Counsel advises EM on issues such as the applicability of NEPA and other environmental laws, on the impacts and consequences of entering into interagency agreements such as the Rocky Flats Cleanup Agreement, on disputes that evolve from disagreements related to interagency agreements, and on other issues.

The **Chief Financial Officer** (CFO) is responsible for the budget. The CFO provides budget projections to field offices, develops the Department's budget, and prepares budget requests. The CFO tracks expenses and provides reports to Congress related to budget performance.

The **Assistant Secretary for Policy, International Affairs** is responsible for developing policy for the conduct of operations. This office develops policy that impacts operations of field offices in so far as these operations are reflective of foreign and defense initiatives. Such policy issues may result in the decommissioning of facilities as a result of arms reduction agreements.

The **Assistant Secretary for Environment, Safety, and Health** (ES&H) is responsible for the environmental, safety, and health issues throughout the DOE complex. ES&H assures that all applicable standards are employed for the protection of the environment and worker and public safety and health. OSHA regulations are specific to safety and health issues associated with environmental investigations and clean up.

The **Office of the Secretary of Energy Advisory Board** advises the Department on a wide variety of issues. This office analyzes issues that are important to the Department and offers options and advice regarding significant policies that impact Department actions and goals. Some of these issues may be related to national goals for environmental protection and clean up.

The **Assistant Secretary for Congressional, Public, and Intergovernmental Affairs** is responsible for advising the Department and developing policy that is responsive to congressional, public, and other agency needs and goals. It provides input for congressional inquiries and other information to the congress, it responds to public inquiries, and it determines the impacts of other government agency policies and works with those agencies to create a unified policy that meets the needs and goals of all. Some of these policies are related to environmental issues. In some cases, agencies that are responsible for environmental management may have expectations that are not consistent with the Department's policy, goals, or funding capabilities. This assistant secretary is responsible for resolving such conflicts.

The **Office of Economic Impact and Diversity** is responsible for determining the economic impact of the Department's actions on the community and assures that the Department is responsive to labor policies regarding employment and contracting.

The **Office of Quality Management** is responsible for assuring that all quality requirements are implemented and achieved. This office conducts inspections and tests that determine the reliability and quality of the products associated with the varied offices and their missions within the complex. EM products include successful clean up and closure of sites, adequate investigation and reporting of environmental issues, among others.

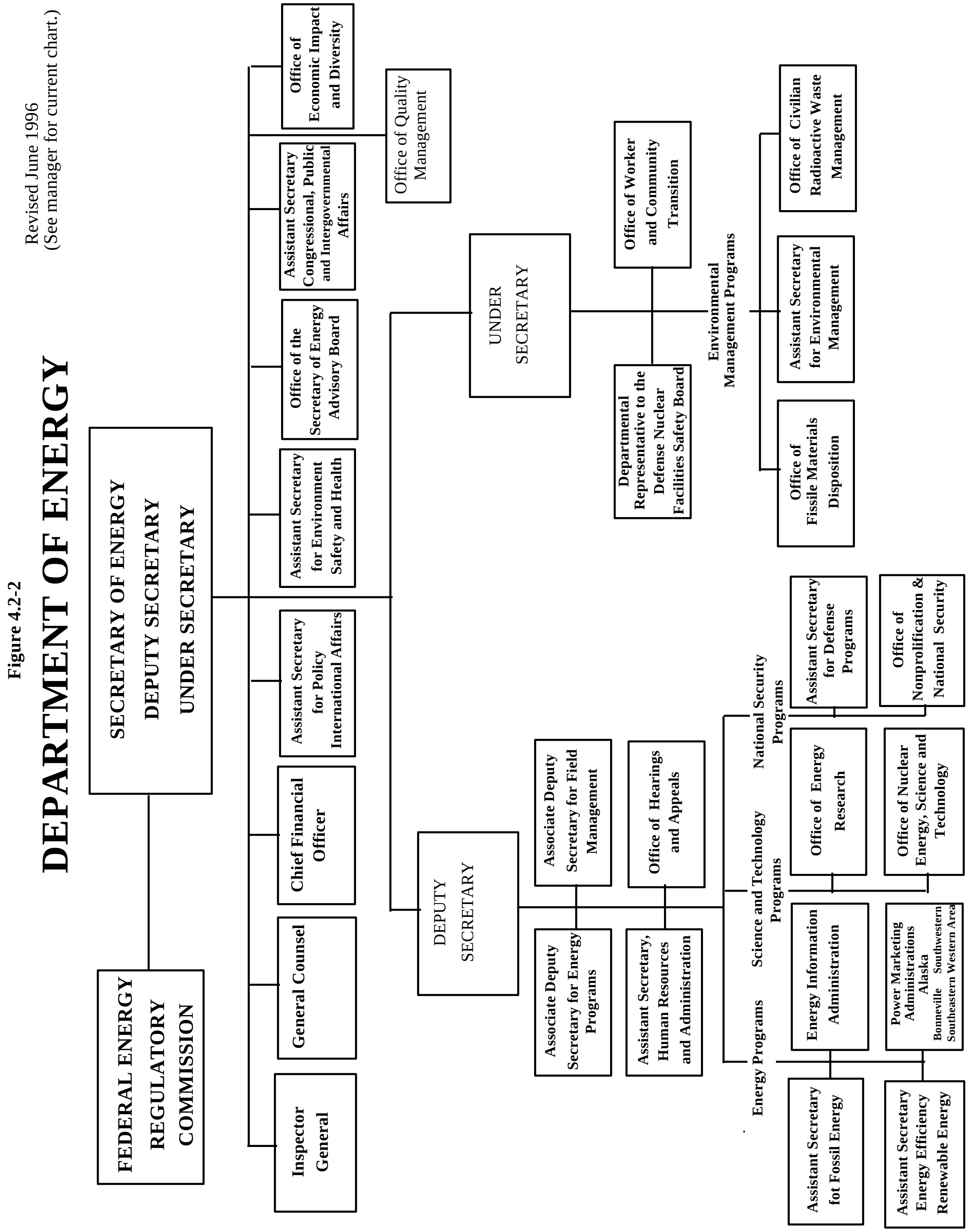

Revised June 1996
(See manager for current chart.)
DEPARTMENT OF ENERGY
SECRETARY OF ENERGY
DEPUTY SECRETARY
UNDER SECRETARY
FEDERAL ENERGY REGULATORY COMMISSION
Inspector General
General Counsel
Chief Financial Officer
Assistant Secretary for Policy International Affairs
Assistant Secretary for Environment Safety and Health
Office of the Secretary of Energy Advisory Board
Assistant Secretary Congressional, Public and Intergovernmental Affairs
Office of Economic Impact and Diversity
Office of Quality Management
UNDER SECRETARY
Office of Worker and Community Transition
Departmental Representative to the Defense Nuclear Facilities Safety Board
Environmental Management Programs
Office of Fissile Materials Disposition
Assistant Secretary for Environmental Management
Office of Civilian Radioactive Waste Management
DEPUTY SECRETARY
Associate Deputy Secretary for Energy Programs
Associate Deputy Secretary for Field Management
Assistant Secretary, Human Resources and Administration
Office of Hearings and Appeals
Energy Programs
Science and Technology Programs
National Security Programs
Assistant Secretary fot Fossil Energy
Assistant Secretary Energy Efficiency Renewable Energy
Energy Information Administration
Power Marketing Administrations Alaska Bonneville Southwestern Southeastern Western Area
Office of Energy Research
Office of Nuclear Energy, Science and Technology
Assistant Secretary for Defense Programs
Office of Nonproliferation & National Security

Figure 4.2-2

c. ***List other Federal agencies, and/or sub-elements of those agencies that play a role, both technological and regulatory, in the environmental restoration of Department sites and describe their role(s).***

The EPA is heavily involved in the oversight of environmental efforts at DOE sites. DOE must work closely with EPA Headquarters and EPA regions, as appropriate, on environmental matters. EPA and/or delegated states, are responsible for oversight of most environmental laws (including CAA, CWA, TSCA, etc.).

Under the requirements of the Endangered Species Act (ESA), DOE must consult with the U.S. Fish and Wildlife Service (USFWS) and the Natural Resources Damage Assessment regarding issues associated with threatened and endangered species.

The DOE is required to consult with the Council on Environmental Quality (CEQ) on issues associated with DOE implementation of NEPA by CEQ regulations. For example, when DOE prepared changes to the DOE's NEPA regulations (found at 10 CFR 1021), DOE was required to consult with CEQ.

d. ***Describe the types and locations of Environmental Management's integrated programs and integrated demonstrations, including industry participants where applicable.***

The Office of Science and Technology (formerly the Office of Technology Development) of the Office of Environmental Restoration and Waste Management, also known as EM-50, was created in 1989 to advance new and improved environmental restoration and waste management technologies in order to reduce risks, reduce cleanup costs, and devise methods to correct problems with no current solutions. The initial EM-50 organizational approach was to identify cleanup problems which would benefit from new technology, identify areas and organizations that could be technology providers, and identify specific problems where these new technologies could be applied. Projects to develop similar types of technologies were grouped together into Integrated Programs and projects to demonstrate the applications of new technologies on particular problems were grouped together into Integrated Demonstrations.

The use of Integrated Programs allowed similar technologies to be evaluated against each other by knowledgeable individuals, both to determine promising candidate technologies and to monitor ongoing development projects. This funding of applied research was designed to create a suite of technologies from which a specific method could be selected for a particular application. Integrated Program technical participants included groups from the sites, laboratories, universities, industry, regulators, and the public. Examples of Integrated Programs were Characterization, Monitoring, and Sensor Technology; Efficient Separations and Processing; and Robotics Technology Development.

Integrated Demonstrations concentrated on the technologies necessary to cleanup specific problem areas; identifying problems that are not amenable to existing cleanup technology (such as "needs"), matching of multiple and different technologies to resolve those needs, and developing specific demonstration projects. Integrated Demonstrations allowed performance of related technologies to be evaluated as a complete system. Similar needs and demonstration projects could be rated against each other as a basis for funding priority. Examples of Integrated Demonstrations were Facility Transition, Decommissioning, and Final Disposition; High-Level Waste Tanks, Mixed-Waste Landfill, and Volatile Organic Compounds in Arid Soils. Other individual demonstration projects were funded directly through Technical Task Plans (TTPs).

Beginning in 1994, EM-50 began to reorganize in order to achieve greater interaction between the developers and the ultimate customers and to improve stakeholder and regulator involvement into the technology selection process. As a result of this reorganization, Focus Areas and Site Technology Coordination Groups (STCG) were created. Integrated Programs essentially carried on as "Crosscutting Programs."

The creation of Focus Areas was principally based on the recognition that technology development needed to be more user-driven. The core of the Focus Area is a management team which performs the day-to-day program management of the Focus Area, and is assigned to a responsible field office. The oversight of all Focus Areas are provided by routine meetings of managers of the responsible field offices with input from the EM program offices (such as EM-30, EM-40, EM-60, and EM-70). Focus Area peer review is provided on an as-needed basis for evaluation of proposals, review of technologies, and program evaluations.

The four EM-50 Focus Areas are as follows, with responsible Field Office in parentheses: Mixed Waste Characterization, Treatment, and Disposal (Idaho); Radioactive Tank Waste Remediation (Richland); Decontamination and Decommissioning (Morgantown); and Subsurface Contaminants (a combination of the previous Contaminant Plume Containment and Remediation and the Landfill Stabilization Focus Areas, Savannah River). There is also a Special Nuclear Material Focus area organized in a similar fashion, but which supports EM-60-funded development and is chaired by an EM-60 representative. While the responsible field offices are located at specific sites, projects funded by their Focus Areas will typically be located at any sites which share this cleanup problem.

The STCG process consists of local STCGs located at each DOE Field Office, and consists of members of the DOE Field Office, with the participation of site contractors, Citizen's Advisory Boards or similar groups, representatives of regulatory organizations, and interested local individuals. STCGs will have individual charters, which may include reviews of projects, development of priority rankings, solicitation of needs input. The STCGs are coordinated at a national level by the EM-50 headquarters organization and serve as site representatives of the customers. Field coordination is provided by the leads for the STCGs (usually the Technical Program Officer) and an EM-50 coordinator.

Industry participation in the technology development process can occur in several ways. Two of the vehicles used in the past are Cooperative Research and Development Agreements (CRADAs), Program Research and Development Announcements (PRDAs), and Research Opportunity Announcements (ROAs). CRADAs are typically joint industry-DOE cost sharing agreements whereby a portion of material and labor necessary to demonstrate a new technology is provided by the company seeking to market the technology, and a portion is funded by DOE. PRDAs and ROAs request proposals for contracts, grants, or cooperative agreements for general types of R&D or development. Industry is also invited to participate in the STCG process and in numerous activities such as the Technology Information Exchange workshops, trade shows, and other forums. Industry is also expected to participate in projects such as integrated demonstrations, as subcontractors in site programs, and through privatization and outsourcing initiatives.

e. Explain how the Small Business Innovative Research Program functions and how this program can be used to improve private sector awareness of environmental restoration programs.

The Small Business Innovative Research Program is a cooperative government/private sector effort to solve environmental problems, and it constitutes an opportunity for small firms engaged in environmental research to solve problems the DOE faces in cleaning up the environment. Participants in the program have an opportunity to pursue their own research if it meets a DOE need. The program uses a phased approach that provides funding as an opportunity to define the project (Phase I), develop and test the technology (Phase II), and the license of the technology or market the technology to DOE (Phase III).

The solicitation is open all year with awards made semi-annually. The Program Review Board represents DOE, selects topics, evaluates proposals, reviews funded projects, and promotes collaboration with small businesses. A peer review panel provides technical proposal evaluations. Advanced technologies may skip Phase I. Phases II and III are conducted at a DOE facility. Successful Phase I projects can proceed to Phase II on a non-competitive basis. Entry into Phase III is on a case-by-case basis (Small Business Proposal Development Workshop, 1992). The contact for information about entry into the program can be obtained from:

> Joseph Paladino, Manager Small Business Technology Integration Program
> Trevion II, EM-521
> U.S. DOE
> Washington, DC 20585
> (301) 903-7449.

f. Describe the methods by which industry can become involved in Environmental Management-related activities, including as a minimum contracting mechanisms, the Small Business Innovative Research Program, licensing of technology, and Cooperative Research and Development Agreements.

The Northwestern Area developed a performance-based requirements process that allows technology developers within industry to adequately respond to DOE needs. The process enables technology users within DOE to clearly communicate their environmental restoration or decontamination and decommissioning needs, in priority order, to technology developers. The process was described in a Technical Information Exchange Meeting with Industry on Environmental Restoration Needs in the Northwestern United States in January 1994 and is available in "Outreach to Industry: Partnerships for the Future, Volume 1, Performance-Based Needs (CONF-940145). This document describes the performance-based needs of the Northwestern Area. These needs are grouped as high, medium, and low. The specific needs of each office are then presented along with local contacts. Presumably, technology developers can determine what the performance requirements are, what the extent of the need or market for any new technology is, and the DOE contact with the need.

Cooperative Research and Development Agreements (CRADAs) were created by the National Competitiveness Technology Transfer Act of 1989. CRADAs allow Federal laboratories, with the prior approval of DOE, and industrial partners to enter into joint ventures to develop new technologies. The purpose is to promote technology transfer and enhance collaboration with U.S.-based manufacturers, fostering the development of technologies in areas of significant economic potential.

As part of the National Defense Authorization Act for Fiscal Years 1990 and 1991 (Public Law 101-189), Congress enacted the National Competitiveness Technology Transfer Act (NCTTA) of 1989. The law further amends the Stevenson-Wydler Technology Innovation Act of 1980, which was previously amended by the Technology Transfer Act of 1986. The NCTTA directed DOE to offer contract provisions to establish technology transfer as a mission of DOE Government-owned, Contractor-operated (GOCO) research and development laboratories, setting forth new contract provisions and operating requirements for government agencies and their GOCO. In addition, the law provides GOCO R&D laboratory directors with the authority to negotiate and enter into CRADAs subject to approved joint work statements, similar to authority previously granted to the directors of Government-owned, Government-operated R&D laboratories.

The technology transfer mission of the R&D laboratories and facilities, including CRADAs, will be conducted in a manner that is consistent with the policy, principles, and purposes of the Stevenson-Wydler Technology Innovation Act of 1980 (as amended) [15 U.S.C. 3710 (a)]; Section 3132 (b) of Public Law 101-189; Chapter18 of Title 35, U.S. Code, commonly referred to as Bayh-Dole (35 U.S.C. 200 et seq); Section 152 of the Atomic Energy Act of 1954 (as amended) (42 U.S.C. 2182); Section 9 of the Federal Nonnuclear Energy Research and Development Act of 1974 (42 U.S.C. 5908); and Executive Order 12591 of April 10, 1987, and consistent with the overall technology transfer mission of the Department. The Office of Naval Nuclear Reactors will continue to perform technology transfer in accordance with applicable laws and existing program policies.

Any inventions that result from CRADA activities shall be the property of the party (government or private entity) whose personnel made the invention. The inventing party shall provide the other party a license to use the invention. If personnel from both parties participated in the invention, the ownership shall be jointly held (Small Business Proposal Development Workshop, 1992).